Volume 21, Number 17 September 15, 1967

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 30429, 30710, 30760, and 31777.

30344 (EUR-3298.f) ETUDE SUR LA PHOTOACTIVATION NUCLEAIRE PAR RAYONS X. (Research on Nuclear Photoactivation by X-Rays). Boivin, M.; Cauchois, Y.; Heno, Y. (Paris Univ., Orsay (France). Faculte des Sciences). Apr. 1967. 36p. (In French). Dep.

Research was carried out to determine whether nuclear photoactivation by x rays could be employed as a method of analysis, if not generally at any rate in certain cases, so as to assess the value of such a method against neutron activation and x-spectroscopy, for instance. This study covers the following items: determination of the photoactivation energies and the lowest x-intensities or doses at which photoactivation is followed by observable emissions; determination of the minimum absolute quantities and relative concentrations of the various pure or mixed elements suitable for analysis; research on the possible uses of nuclear photoactivation by x rays; and an estimate of the effective cross-sections of photoactivation versus energy. The task was to reach conclusions quickly as to the practical aspects of the method, specifying whether x-ray tubes, operating at a voltage of definitely less than 2 MV, but if necessary at high intensity, would be suitable for interesting specific applications. (auth)

30345 (IN-1063) ANNUAL REPORT OF THE ANALYTICAL CHEMISTRY BRANCH FOR 1966. (Idaho Nuclear Corp., Idaho Falls). Apr. 1967. Contract AT(10-1)-1230. 160p. Dep. CFSTI.

Research progress is reported on: classical methods of analysis, radiochemical methods of analysis, electroanalytical studies, development in support of LOFT program, remotely operated facilities, spectrochemical analysis, mass spectrometers, analytical services, improvements in methods and equipment, and standards and quality control. (M.C.G.)

30346 (IS-T-120) NEUTRON ACTIVATION ANALYSIS OF TRACE RARE EARTHS IN HOLMIUM OXIDE. Hunt, Lee Philip (Ames Lab., Iowa). Feb. 1967. Contract W-7405-eng-82. 70p. Dep. CFSTI.

Thesis.

A method is described for the determination of trace rare earth impurities in a holmium oxide matrix. Two approaches to the problem were investigated based on a destructive method of thermal neutron activation analysis. Rare earth standards were used as comparators and radiation was measured with a gamma scintillation spectrometer. One method of analysis involved the irradiation of 100 mg Ho_2O_3 samples doped with known amounts of thulium followed by the separation of holmium and thulium with EDTA on a cation exchange resin in the cadmium cycle. The accuracy of the thulium analyses in the 10 to 100 ppM range was better than ±4%. Thulium could not be analyzed at the 1 ppM level due to the inability to separate thulium from the ytterbium impurity originally in the samples. Suggestions are presented for the analysis of trace impurities in other rare earth matrices by using ions other than cadmium to act as a wedge to facilitate the separation of two rare earths. The second method of analysis involved the separation of trace rare earth impurities from 10 mg irradiated samples of spec-pure holmium oxide by reversed-phase partition chromatography. Separations were effected by step-wise gradient elution with nitric acid on a column of kieselguhr with bis-(2-ethylhexyl) phosphonic acid as the stationary phase. Impurities of Eu, Gd, Tb, Tm, Yb, and Lu were determined in the 0.3 to 10 ppM range with a precision of approximately ±2%. Other impurities found to be present, but not determined, were Sm, Dy, and Y. Application of the second method of analysis to matrices other than holmium is discussed. (auth)

30347 (IS-T-144) SOME ANALYTICAL APPLICATIONS OF ESTERS OF PHOSPHOROTHIOIC AND PHOSPHORODITHIOIC ACIDS. Schmitt, Martha Ann Sudholt (Ames Lab., Iowa). Feb. 1967. Contract W-7405-eng-82. 41p. Dep. CFSTI.

Thesis.

Sodium diisooctyl and diheptylphenyl phosphorodithioate and di-n-butyl phosphorothioic acid were studied as the immobile phases in ascending reversed-phase partition paper chromatography. R_f values were recorded for twenty-nine cations. Distribution ratios for thorium(IV), zirconium(IV), lanthanum(III), erbium(III), and calcium(II) with di-n-butyl phosphorothioic acid in hydrochloric acid–carbon tetrachloride systems were investigated. The quantitative separations of thorium(IV) and erbium(III) and calcium(II) and erbium(III) by liquid-liquid extraction were achieved. (auth)

30348 (ISO-SA-37) THE EVALUATION OF A LOCK-IN AMPLIFIER FOR USE WITH SINGLE-BEAM ATOMIC ABSORPTION SYSTEMS. THE ANALYSIS OF CALCIUM, MAGNESIUM, PALLADIUM, RHODIUM, AND STRONTIUM. Sandoz, D. P. (Isochem Inc., Richland, Wash.). May 1, 1967. Contract AT (45-1)-1851. 31p. (CONF-670620-2). Dep. CFSTI.

From Northwest Regional Meeting of the American Chemical Society, Richland, Wash.

The evaluation of a lock-in amplifier for use with an atomic absorption spectrophotometer was completed. The high signal to noise ratio of this amplifier allowed expansion of the recorder scale resulting in an increase in sensitivity by a factor of 10 for many elements analyzed by atomic absorption spectroscopy. The development of analytical procedures for determination of palladium and rhodium with an atomic absorption spectrophotometer was completed. This analytical method can be used to determine palladium and rhodium in Purex waste solutions, 10% Aliquat-336 dissolved in CCl_4, 4M NH_4SCN–1.5M NH_4OH, 4M NH_4NO_3, 1.5M NH_4OH, 5M $NaNO_3$, CH_3OH, and water. Sensitivities for these two elements in the above solutions varied from 0.3 to 2.5 ug/ml, depending on the solution matrix. Analytical procedures were also developed for determination of calcium, magnesium, and strontium in process essential materials with the atomic absorption spectrophotometer. Sensitivities for these three elements ranged from 0.5 to 3, 0.07 to 0.4, and 0.04 to 4 ug/ml, respectively, depending on the solution matrix and instrumentation. (auth)

30349 (K-1683) SPECTROCHEMICAL DETERMINATION OF IMPURITIES IN TUNGSTEN. Farrar, R. B.; Randolph, D. C. S.; Sullivan, H. H. (Oak Ridge Gaseous Diffusion Plant, Tenn.). July 5, 1967. Contract W-7405-eng-26. 41p. Dep. CFSTI.

Twelve spectrochemical procedures were developed for the determination of impurities in tungsten. These procedures include a direct burn method for calcium, eight carrier distillation procedures for common metals, the cupferron group separation, the platinum group separation by zinc reduction and separation of the rare earth elements using an ammonia precipitation. Sixty-one elements are measurable; fifty-six of the elements are determinable in the range of 0.1 to 3 ppM. (auth)

30350 (NBL-238) ANALYSIS OF REACTOR FUEL ELEMENT SOLUTIONS. I. SEPARATIONS AND PREPARATION OF SAMPLES FOR MASS SPECTROMETRY AND ALPHA SPECTROMETRY. II. MASS SPECTROMETRIC DETERMINATION OF URANIUM AND PLUTONIUM CONCENTRATION AND ISOTOPIC COMPOSITION. III. ALPHA SPECTROMETRIC DETERMINATION OF ^{238}Pu. Pietri, C. E.; Wenzel, A. W.; Jasper, L. J. Jr.; Finley, H. O.; Nelson, L. C. Jr. (New Brunswick Lab. (AEC), N. J.). May 1967. 44p. Dep. CFSTI.

Procedural details are given for the determination of uranium and plutonium isotopic composition and concentration in reactor fuel element solutions. The necessary chemical operations, the mass-spectrometric determination of isotopic composition and concentration, and the alpha-spectrometric determination of ^{238}Pu are described. (auth)

30351 (NYO-4700(2nd Ed.)) MANUAL OF STANDARD PROCEDURES. Harley, John H. (ed.) (New York Operations Office (AEC), N. Y. Health and Safety Lab.). First Issued 1957, Second Issuance 1967. 540p. CFSTI.

Methods for the radiochemical determination of fission products and other radionuclides in biological and environmental samples are presented. The methods have been tested for reliability and simplified during use over a period of years. Emphasis is placed on methods for the evaluation of radioactivity due to fallout. Fundamental properties of radiation are discussed, radiation detectors and their applications are described, decay schemes for various radioisotopes, and constants and conversion factors are included. Procedures for sample collection, sample preparation, separation procedures, chemical procedures, counting procedures, and procedures for data analysis, including computer methods, are described. Procedures for the collection of fallout and dust samples are included. Photographs and schematic sketches of equipment used and a list of references are also included. (C.H.)

30352 (PHS-999-RH-27) RADIOASSAY PROCEDURES FOR ENVIRONMENTAL SAMPLES. (National Center for Radiological Health, Rockville, Md.). Jan. 1967. 497p. Public Health Service, Washington, D. C. Free.

A manual of methods used in laboratories of the Public Health Service's National Center for Radiological Health of the Bureau of Disease Prevention and Environmental Control for the determination and interpretation of the radionuclide content of samples collected for environmental surveillance is reviewed. Step by step procedures are given for the analysis of milk, food, air, water, and other environmental samples. A discussion of instrumentation for these procedures is given, and a program of analytical quality control is described. Appendices include a definition of laboratory practice and terminology and instructions for preparing required reagents. Bibliographic references are included for specific procedures as well as for more general discussions. (auth)

30353 (UCID-15140) IDENTIFICATION AND DETERMINATION OF GAMMA EMITTERS BY COMPUTER ANALYSIS OF Ge(Li) SPECTRA. Gunnink, R.; Levy, H. B.; Niday, J. B. (California Univ., Livermore. Lawrence Radiation Lab.). May 16, 1967. Contract W-7405-eng-48. 23p. (CONF-670401-10). Dep. CFSTI.

From 153rd National Meeting, American Chemical Society, Miami Beach, Fla.

An application of the Ge(Li) gamma detector is its usefulness as a nondestructive analytical tool. However, the data from such systems are typically contained in 1000 to 4000 channels of a pulse-height analyzer and the gamma spectra are frequently complex. To reduce the effort of spectral interpretation to a minimum, a computer code was developed that will make an identification and quantitative determination of the isotopic components producing the complex Ge(Li) gamma spectrum. In addition to the general approach and operating considerations used in a quantitative analysis of this type, features of the computer code are discussed and typical results shown. The characteristics of the computer code are location of peaks in a spectrum, determination of the area of peaks, treatment of interferences of adjacent peaks, determination of precise peak energies, calculation of peak intensities, identification of the isotopes responsible for the peaks by using a library tape containing the necessary decay scheme information, and final calculation and tabulation of results. (auth)

30354 (UCID-15153) THERMOCHEMICAL SEPARATION AND SPECTROGRAPHIC DETERMINATION OF IMPURITIES IN RHENIUM. Stevens, J. R.; Morris, W. F. (California Univ., Livermore. Lawrence Radiation Lab.). May 10, 1967. Contract W-7405-eng-48. 10p. Dep. CFSTI.

A method that is capable of detecting individual impurities in Re to less than 0.1 ppM is described. It combines thermochemical separation of volatile rhenium oxide and spectrographic determination of the residual impurities in a suitable collector. Detection limits for 26 elements are given. (P.C.H.)

30355 (UCRL-5133) ANALYSIS AND DESTRUCTION OF LITHIUM HYDROXIDE IN LITHIUM HYDRIDE. Frazer, Jack W. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 24, 1958. Contract W-7405-eng-48. 10p. Dep. CFSTI.

The conditions for destruction of lithium hydroxide impurity in lithium hydride compacts have been studied, and an analytical procedure is described for the determination of ≥100 ppM by weight lithium hydroxide in lithium hydride. (auth)

30356 (ORNL-tr-1612) DETERMINATION OF OXYGEN AND HYDROGEN IN SODIUM. Subbotin, V. I.; Kozlov, F. A.; Kuznetzov, E. K.; Ivanovskii, N. N. Translated for Oak Ridge National Lab., Tenn., from paper presented at the IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna, Austria, November 29–December 2, 1966. 25p. (CONF-661110-34). Dep. CFSTI. JCL $2.60 fs, $0.95 mf.

The vacuum-distillation method was used to determine the oxygen concentration in sodium. The parameters of this method, based on theoretical considerations and experiments, showed a good reproducibility and comparatively small error. The method permits the determination of an oxygen concentration in sodium of the order to (2 to 5) × 10^{-4} wt %. The hydrogen diffusion indicator was used to determine the hydrogen in sodium. It appeared to be the most sensitive and selective method that permits the tests to be performed directly in the operating plant. The sensitivity of this method amounts to (1 to 2) × 10^{-4} wt %. The optimum working parameters for the sample indicator were determined and its usefulness for the determination of oxygen, hydrogen, and of the reaction products of sodium with water were examined. The sample indicator did not appear to be a selective apparatus but its indications are valuable because it shows the total concentration of the dangerous contaminants from the point of view of their precipitation in the coldest section of the system. (D.H.M.)

30357 DETERMINATION OF THE VANADIUM CONTENT IN PETROLEUMS PROCESSED IN HUNGARY BY MEANS OF ACTIVATION ANALYSIS. Vajta, Laszlo; Palmai, Gyorgy; Szebenyi, Imre; Toth, Geza (Technical Univ., Budapest). Period. Polytech. Chem. Ing., 10: 269-78(1966). (In German).

Crude oil samples were analyzed for vanadium content by means of activation analysis. The samples were encased in Cellothen foil (commercial polyethylene–cellophane combination) and irradiated in a Hungarian research reactor (flux ~5 × 10^{12} n/sec sq cm) for 10 seconds. The γ spectrum of the activated samples was obtained in the KFKI 128-channel analyzer. The vanadium content was determined on the basis of the 1.44-MeV photopeak of ^{52}V. The techniques and the dependability of the method are described. The vanadium losses of the samples ranged between 0.5 and 8.8% of the total. (JPRS)

30358 DETECTION OF WEAK BETA EMITTERS BY LIQUID SCINTILLATION COUNTING TECHNIQUES. Nagy, Gyorgy Lajos; Torok, Gabor; Szarvas, Tibor (Polytechnical Univ., Budapest. National Commission for Atomic Energy, Budapest). Period. Polytech. Chem. Eng., 10: 279-302(1966).

The devices tested were the SK-2 with LL-1 Model B scaler and EMI 9514 S photomultiplier, and the Packard Tri-Carb spectrometer (Model 3003) equipped with a triple-channel analyzer. The aim of the investigations was to establish the stability of the instruments, to evaluate the photomultipliers, to establish the optimum operating conditions, and to determine the accuracy that may be obtained by determining the absolute ^{14}C activity by the extrapolation method. Under the optimum conditions a 92% accuracy could be obtained by extrapolation. The techniques employed and the results obtained are presented and discussed in considerable detail. (JPRS)

30359 METHOD FOR SCANNING RADIOCHROMATOGRAMS. Wagner, V.; Forcheri, S. (EURATOM-CCR, Petten, Netherlands). Energ. Nucl. (Milan), 14: 380-3(June 1967).

A method for analysis of radiochromatograms in which a double reading procedure is coupled with a scanning performed by leaving the strip always in contact with the collimator is described. The sample-holder collimator is the fixed seat of gliding for the strip and the counter is placed in a position reversed to the usual one. The paper chromatograms are stuck to a rigid support and placed on the collimator with the active side in contact with the collimator. The reading characteristics of the apparatus are discussed. The resolving power was checked on strips presenting different activity peaks. (M.C.G.)

30360 ION-EXCHANGE MEMBRANES IN RADIOCHELATOMETRIC TITRATIONS OF TRACES OF METALS. Toelgyessy,

J.; Konecny, J.; Braun, T. (Slovak Technical Univ., Bratislava). Nucl. Appl., 3: 383-9(June 1967).

Ion-exchange membranes can be used to separate reaction products from the initial components in radiochelatometric titrations. Their use speeds up and simplifies the titration. By this method traces of cobalt and zinc were determined with 10^{-3} M EDTA or DCYTA solutions as titrants. (auth)

30361 ACTIVATION ANALYSIS OF HIGH-PURITY LUBRICANTS FOR TRACE ELEMENTS. Jester, W. A.; Klaus, E. E. (Pennsylvania State Univ., University Park). Nucl. Appl., 3: 375-82(June 1967).

Neutron activation techniques were used to measure quantitatively trace impurities in mineral oils and organic esters. These impurities include arsenic, bromine, chlorine, cobalt, copper, manganese, mercury, sodium, and sulfur. The effects of processing and refining on the concentrations of the trace constituents are demonstrated. The effects of trace constituents on response of the overall fluid to oxidation inhibitors and lubricity additives are indicated. (auth)

30362 ACTIVATION ANALYSIS OF TITANIUM BY MEANS OF THE (γ,p) REACTION. I. ACTIVATION ANALYSIS OF TITANIUM IN IRON BY PHOTONUCLEAR REACTION. Abe, Shigeki (Yamagata Univ., Japan). Nippon Kagaku Zasshi, 87: 710-4(July 1966). (In Japanese).

Based on results of photoactivation of Ti and Fe, a method for nondestructive determination of Ti in Fe was developed. Titanium and iron oxides were irradiated for an hour with a 20-MeV bremsstrahlung generated from a linear electron accelerator. The γ spectrum of the irradiated Ti showed prominent photopeaks at 0.16 and 0.51 MeV. Those photopeaks were attributed to ^{47}Sc ($T_{\frac{1}{2}}$ = 3.43 day) and ^{45}Ti ($T_{\frac{1}{2}}$ = 3.07 hr) which were produced by (γ,p) and (γ,n) reactions with Ti. With the Fe, three photopeaks were observed at 0.85, 1.81, and 2.13 MeV. These were attributed to ^{56}Mn which was produced from ^{57}Fe by the (γ,p) reaction, the half-life of which is 2.58 hr. For determination of Ti in iron oxide, the ^{56}Mn activity was used as internal monitor for photon flux intensity. The activity ratios of ^{47}Sc, (0.16 MeV)/^{56}Mn, (0.85 MeV) at photopeaks vs the weight ratios of Ti/Fe were plotted for various synthetic samples and a linear relationship was obtained. Thus Ti in iron oxide was determined nondestructively to about 0.1%. (NSA of Japan)

30363 ACTIVATION ANALYSIS OF TITANIUM BY MEANS OF THE (γ,p) REACTION. II. PHOTOACTIVATION OF VANADIUM AND ITS APPLICATION FOR THE DETERMINATION OF TITANIUM IN VANADIUM. Abe, Shigeki (Yamagata Univ., Japan). Nippon Kagaku Zasshi, 87: 714-7(July 1966). (In Japanese).

An investigation of the photonuclear reaction of V was carried out to obtain the yield for the reaction $^{51}V(\gamma,\alpha)^{47}Sc$. Vanadium oxide was irradiated for an hour with a 20-MeV bremsstrahlung generated from a linear electron accelerator. The γ spectrum of irradiated V showed a prominent photopeak at 0.16 MeV, which was attributed to ^{47}Sc ($T_{\frac{1}{2}}$ = 3.43 day) produced by the (γ,α) reaction. For calculation of the yield of ^{47}Sc, the ^{56}Mn activity produced by the (γ,p) reaction from Fe was used as an internal monitor of photon flux intensity. The relative yield of $^{48}Ti(\gamma,p)^{47}Sc/^{51}V(\gamma,\alpha)^{47}Sc$ was found to be 35.6 ± 0.6 with 20 MeV bremsstrahlung. A method for nondestructive determination of Ti in V was shown. Titanium content in $V_2O_5-TiO_2$ mixtures can be determined to ~1% by using ^{56}Mn as a photon flux monitor. (NSA of Japan)

30364 APPLICATION OF RADIOISOTOPES FOR ANALYSES. V. NEUTRON ACTIVATION ANALYSIS OF AGRICULTURAL SAMPLES. Shibuya, Masao (National Inst. of Agricultural Science, Tokyo). Nippon Dojo Hiryogaku Zasshi, 37: 126-39 (Jan. 1966). (In Japanese).

Neutron activation analysis for determination of ^{55}Mn is described. Only a single grain of rice is needed as a sample. Determination of concentrations of mercury as low as 0.001 ppM in rice samples is also described. Analyses of plant samples for Mn, Cu, Na, Sb, and Zn are discussed. The principles, techniques, advantages and disadvantages of neutron activation analysis are considered. (TSS)

30365 MEASUREMENT OF ^{14}C AND ^{3}H WITH LIQUID SCINTILLATION COUNTER. Kihara, Hirozi; Ichikawa, Yoichi (Keio Univ., Japan). Keio Igaku, 43: 279-87(May 1966). (In Japanese).

Conditions for ^{14}C and ^{3}H measurement in aqueous samples using liquid scintillation counters were studied. Effects of quenching were corrected successfully by the channel-ratio method. When quenching effects were quite severe, the corrected figures were unreliable. This situation was alleviated by changing counting conditions for ^{14}C. (NSA of Japan)

30366 SIMULTANEOUS DETERMINATION OF ^{14}C AND ^{3}H WITH LIQUID SCINTILLATION COUNTER. Ichikawa, Yoichi; Kihara, Hirozi (Keio Univ., Japan). Keio Igaku, 43: 289-95 (May 1966). (In Japanese).

A method for discriminative determination of ^{14}C and ^{3}H by single counting using a liquid scintillation counter was developed on the basis of a screen-out method and a channel-ratio method. Correction for quenching was performed by referring to the relationship between counting efficiency of ^{14}C and the channel ratio of two scalers for ^{14}C counting. Correlations between quenching effects for ^{14}C and for ^{3}H and relations between counting efficiency of ^{14}C in the scaler for ^{14}C counting and that in the scaler for ^{3}H counting were established. On the basis of these three relations, ^{14}C and ^{3}H amounts corrected for quenching were easily obtained by simple calculations. Examples of actual counting conditions are given. Counting efficiencies ranged from 50 to 10% for ^{14}C and 30 to 10% for ^{3}H. (NSA of Japan)

30367 ON THE FEASIBILITY OF ESTABLISHING INDIVIDUALITY BY ACTIVATION ANALYSIS OF HUMAN HAIR. Kozuka, Hiroshi; Niwase, Takeshi (National Research Inst. of Police Science, Tokyo). Eisei Kagaku, 12: 187-90(Aug. 1966). (In Japanese).

Neutron activation analysis of hair samples from 10 Japanese persons (5 males and 5 females) was performed to investigate the feasibility of establishing individuality. Hair samples were irradiated for 5 hours in a thermal neutron flux of 2×10^{12} n/cm² sec. The gross γ activity and the decay of the activity were determined, and γ spectrometry was performed with a 256 channel pulse height analyzer without chemical separation. Micro contents of trace elements such as Na, Mn, Cu, Br, and Au were determined by the spectra. The patterns of spectra were slightly different in micro parts and useful for establishing individuality. The individuality was remarkable at the 0.41-MeV energy peak of Au. A simple way to individualize samples was to compare the patterns of spectra of samples that had similar Na contents since the Na content was correctly determined by the nondestructive method. (NSA of Japan)

30368 QUANTITATIVE ACTIVATION OF THE IMPURITIES IN A CULTURED PEARL. Furuhashi, Nobuyuki; Uemura, Teiji (Industrial Research Inst. of Osaka Prefecture). Osaka Furitsu Kogyo-Shoreikan Hokoku, No. 39, 46-9(July 1966). (In Japanese).

Small amounts of impurities (Mn, Na) in the culture pearls were determined quantitatively by neutron activation. It was found that radiation coloring of pearls is due to inclusion of Mn and not due to Na. Quantitative analysis was achieved by calculations from γ energy peaks for ^{56}Mn (0.845 MeV) and ^{24}Na (1.368 MeV). Concentrations of Mn of over 300 ppM were found in the nucleus of the pearls, while less than 50 ppM were found in a layer and only about 3 to 4 ppM in a golden layer. On the other hand, higher concentrations of Na were found in the layers than in the nucleus. (NSA of Japan)

30369 DETERMINATION OF IMPURITIES IN SILICON BY ACTIVATION ANALYSIS. Simkova, M.; Pinkas, V. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Isotopenpraxis, 3: 88-91(Mar. 1967). (In German).

The content of arsenic, antimony, copper, phosphorus, and zinc in semiconductor-grade silicon was determined by activation analysis. The method consists of two stages: separation of the groups by anion exchange using a mixture of hydrochloric and hydrofluoric acids; and, selective substoichiometric extraction of arsenic and copper by diethyldithiocarbamate, of antimony by cupferron, and of zinc by dithizon. Phosphorus was separated extractively in the form of phosphomolybdate. The content of the impurities mentioned above was 10^{-2} to 10^{-3} ppm. The duration of one analysis was about 12 hr. (auth)

30370 RADIOACTIVITY IN PEREMESIN. Schwenke, W. (Paedagogische Hochschule, Potsdam, Ger.). Isotopenpraxis, 3: 91-4(Mar. 1967). (In German).

Peremesin (a colloidal cerium oxalate) and other substances containing cerium often include radionuclides of the thorium series. The radiochemical separation of the isotopes of radium $MsTh_1$ and ThX by coprecipitation allowing the qualitative and the approximated quantitative determination of the parent nuclide ^{232}Th is described. The analyzed peremesin contained about 4.2 mg thorium per gram peremesin. (auth)

30371 CHEMICAL TREATMENT OF NITROGEN COMPOUNDS LABELED WITH ^{15}N IN THE MICROMOLE TO NANOMOLE SCALE FOR ISOTOPE ANALYSIS BY EMISSION SPECTROMETRY. Faust, H. (Institut fuer Stabile Isotope, Leipzig). Isotopenpraxis, 3: 100-3(Mar. 1967). (In German).

A technique for the chemical treatment of nitrogen compounds labeled with ^{15}N in the micromole to nanomole scale was studied. A simple method for the study of small amounts of nitrogen (2 to 5 μg) with regard to their ^{15}N abundance also in series measure-

ments is described. It is based on the method of dry combustion of the nitrogen compound and the oxidation of ammonia to molecular nitrogen by copper oxide. The secondary products formed during the reaction are bound by calcium oxide added. Check analyses showed the necessity of completely displacing the nitrogen in air by well-executed heating. Using the stradling technique of isotope dilution analysis the nitrogen content and the ^{15}N abundance in an amount of nitrogen up to 18 nmole was determined with sufficient accuracy. Advantages and disadvantages of the method are discussed. (auth)

30372 AMPHOTERIC ION-EXCHANGE RESINS. II. SIMPLE SEPARATION METHODS FOR CATIONS ON N-METHYL-β-AMINOPROPIONIC ACID-RESINS. Kuehn, G.; Hoyer, E. (Karl-Marx-Univ., Leipzig). Z. Anal. Chem., 228: 166-70(1967). (In German).

Resins containing N-methyl-β-aminopropionic acid (MAP) were used for separations of binary mixtures. The proposed analytical applications are based on the tendencies of the acid of coordinate Cu^{2+}, UO_2^{2+}, Bi^{3+}, Cr^{3+}, and Fe^{3+} while Ni^{2+}, Co^{2+}, Zn^{2+}, Mn^{2+}, Cd^{2+}, Pb^{2+}, Be^{2+}, Tl^{+}, NH_4^{+}, alkali metals, alkaline earths, and rare earths are not retained. The selectivity of the separation can be increased by variations of pH, temperature, and inert-salt background. (B.L.M.)

30373 DETERMINATION OF RADIOCHEMICAL PURITY OF SOME RADIOCHEMICALS AND PHARMACEUTICALS BY PAPER CHROMATOGRAPHY, THIN-LAYER CHROMATOGRAPHY AND HIGH-VOLTAGE ELECTROPHORESIS. Hoeye, Age (Institutt for Atomenergi, Kjeller, Norway). J. Chromatogr., 28: 379-84 (June 1967).

Procedures for the determination of the radiochemical purity of some radiochemicals are described. The methods were verified and found to give reliable results with good reproducibility. Some practical details of experience gained during the study are given. (auth)

30374 NEUTRON ACTIVATION ANALYSIS BY STANDARD ADDITION AND SOLVENT EXTRACTION. DETERMINATION OF TRACES OF THORIUM IN ALUMINIUM BY EXTRACTION OF ^{233}Pa. Alian, A.; Sanad, W. (Atomic Energy Establishment, Cairo). Anal. Chim. Acta, 38: 327-32(July 1967).

A rapid and selective radiochemical separation for protactinium-233 is suggested. The method is based on extraction of protactinium with 0.3 M tridodecylamine from 4.5 M HCl–1.5 M $AlCl_3$ solution, stripping with 1.35 M HCl followed by another extraction with 0.5 M 2-thenoyltrifluoroacetone. The separation, coupled with the application of the standard addition technique, is applied to the determination of traces of thorium in aluminum by neutron activation. (auth)

30375 A RAPID COLORIMETRIC METHOD FOR THE DETERMINATION OF THORIUM IN HUMAN URINE. Bazzano, E.; Ghersini, G. (CISE, Milan). Anal. Chim. Acta, 38: 457-60 (July 1967).

A method, utilizing Arsenazo III, was developed for the toxicological control of thorium in human urine. A procedure, eliminating interference from calcium and organic substances, is described that measures the color development in 7 to 8 M hydrochloric acid at wavelength 665 nm. The precision of the method was determined at the 0.0 and 1.9 μg/l thorium levels in urine samples. The standard deviation was 0.002 for both thorium levels. The procedures had a lower detection limit of 0.6 μg/l, which is more than three times below the minimum investigation level (2 μg/l). The effects of the presence of uranium were investigated and found to be negligible up to 40 μg/l of uranium. Twenty-four samples may be analyzed in one day. (D.H.M.)

30376 DETERMINATION OF TRACE ELEMENTS IN STANDARD REFERENCE MATERIALS BY NEUTRON ACTIVATION ANALYSIS. Smith, Gilbert W.; Becker, Donald A.; Lutz, George J.; Currie, Lloyd A.; Devoe, James R. (National Bureau of Standards, Gaithersburg, Md.). Anal. Chim. Acta, 38: 333-40(July 1967).

Neutron activation analysis with its high sensitivity and accuracy in trace analysis is being used at the NBS for analysis of Standard Reference Materials. Four problems affecting precision and accuracy are discussed. First, the positive bias introduced by induced radioactivity of similar γ-ray energy was found in the determination of interstitial argon in ultra-pure silicon; a decay-curve resolution technique was used to compensate for the error. Secondly, errors due to differences in geometrical location between sample and standard during irradiation were observed; flux gradients were determined by copper foil flux monitoring to give necessary means of correction. Thirdly, errors are caused by differences in neutron self-shielding between sample and standard during irradiation; an empirical correction method was used and a computer program written for calculation. Finally, the problem of γ-ray attenuation during counting of sample and standard was explored; a theoretical and experimental study gives the necessary corrections. (auth)

30377 NEUTRON ACTIVATION ANALYSIS FOR SODIUM TRACES IN MAGNESIUM. Malvano, R. (SORIN, Saluggia-Vercelli, Italy). Anal. Chim. Acta, 38: 341-7(July 1967).

When sodium traces are determined in magnesium matrices by neutron activation analysis, the reaction $^{24}Mg(n,p)^{24}Na$ interferes by simulating spurious sodium concentrations (about 400 to 500 ppM for usual irradiation positions in the RS 1 water-pool reactor). A preliminary separation of the sodium traces from the bulk of the matrix by electrodeposition on a mercury cathode and recovery in water by amalgam decomposition prevented the fast-neutron effects. Electrolysis for 4 hr gave almost quantitative recovery of sodium (93 ± 5%) and satisfactory decontamination factors for magnesium (1.5 to 5.10^3). The method is limited by the blank correction (14 μg Na with a glass electrolysis cell). Some results for magnesium samples with both destructive and nondestructive techniques are reported. (auth)

30378 A SPECTRUM STRIPPING METHOD FOR THE COMPUTER-COUPLED ACTIVATION ANALYSIS OF UNKNOWN SAMPLES BY γ-RAY SPECTROMETRY. Menon, M. P.; Berry, D. W. (Texas A and M Univ., College Station). Anal. Chim. Acta, 38: 349-56(July 1967).

A spectrum stripping method for the computer-coupled activation analysis of unknown samples using γ-ray spectrometry is discussed. Before the unscrambling of the γ-ray is performed using standard spectra of the components, each spectrum is smoothed, statistically weighted, and corrected for background. The photopeaks of the standard spectra are then aligned with the respective peaks of the sample spectrum, one at a time after correcting for gain drift if necessary, and the undesired components are stripped out. After successive subtraction, the characteristic spectrum of the desired element is compared with that of the standard to determine its weight. The results obtained using the present method are as good as those obtained from least-squares analysis in ideal cases, but appear to be better when assumptions inherent in the least-squares method are no longer valid. (auth)

30379 HIGH-PRECISION ANALYSIS OF NUCLEAR MATERIALS BY CONSTANT-CURRENT COULOMETRY. PART II. DETERMINATION OF THORIUM. Goode, G. C.; Jones, W. T. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Anal. Chim. Acta, 38: 363-8(July 1967).

A constant-current coulometric method is described for the precise determination of thorium by titration with EDTA, electrogenerated from its mercury complex in acetate-buffered solution at pH 4.5. With polarised mercury electrodes for end-point detection, relative standard deviations of 0.02 and 0.3% for 30 mg and 30 μg respectively were obtained; the method was applied to the analysis of zone-refined thorium of high purity. (auth)

30380 DIFFERENTIAL CONTROLLED-POTENTIAL COULOMETRY: APPLICATION TO THE DETERMINATION OF URANIUM. Goode, G. C.; Herrington, J. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Anal. Chim. Acta, 38: 369-75(July 1967).

Differential controlled-potential coulometry was investigated as a high-precision analytical technique using the reduction of uranium(VI) in 0.5 M sulfuric acid at a mercury cathode. A relative standard deviation of 0.009% was obtained with 30 to 120 mg samples of uranium and the method was applied to the comparison of uranium standards. (auth)

30381 DETERMINATION OF OXYGEN AND HYDROGEN IN TUNGSTEN AND OTHER METALS BY A VACUUM-FUSION GAS-CHROMATOGRAPHIC METHOD. Wood, D. F.; Wolfenden, G. (Imperial Metal Industries, Ltd., Birmingham, Eng.). Anal. Chim. Acta, 38: 385-402(July 1967).

A gas-chromatographic method was developed for the analysis of gas evolved from tungsten and tungsten-base alloys in the vacuum-fusion process. The method is suitable for determining 5 to 3,000 ppM of oxygen and 0.2 to 300 ppM of hydrogen, and can be applied to other metals. Above 50 ppM of oxygen and 3 ppM of hydrogen, the values found compare favorably with those obtained by alternative methods; below these levels, no reliable alternative procedures are readily available. In the proposed method, the sample is submitted to vacuum fusion in a molten platinum bath in a graphite crucible, and an aliquot of the evolved gas is transferred by means of a specially modified Drallim valve to a stream of high-purity helium. The components are separated on a column of molecular-sieve 5A at 100°C and detected with a radioactive-type ionization detector. Calibration and operation

of the system are described in detail, and the effects of variables are discussed. Evidence was obtained that hydrogen recoveries by the conventional vacuum-fusion method are sometimes slightly low, because of methane formation. An important advantage of the method is that the evolved gases are positively identified by their retention volumes. (auth)

30382 DETERMINATION OF DISSOLVED ^{226}Ra IN WATER. Rushing, D. E. (Dept. of the Interior, Washington, D. C.). J. Amer. Water Works Ass., 59: 593-600(May 1967).

Data on the recovery of ^{226}Ra from a variety of water samples are presented. Radium was coprecipitated with barium from an acidified water sample. The precipitate was filtered off and ignited. The barium–radium sulfates were dissolved by fuming with phosphoric acid, followed by digestion and evaporation with HCl. The radium and barium were dissolved in dilute HCl and transferred to a special bubbler for radon ingrowth. After a suitable period of radon ingrowth, the bubbler was de-emanated into a scintillation cell. When radon decay products came to transient equilibrium with radon, the alpha activity in the scintillation cell was determined in a scintillation counter. From the data, the amount of ^{226}Ra in the original sample was calculated. Results are tabulated for both spiked and unspiked duplicate water samples. The average recovery of the added ^{226}Ra was 100.2% with a standard deviation of the mean of 0.31% and a probable error of the mean of 0.21%. A discussion of problems related to the preservation of samples during the period between collection and analysis is given. (D.H.M.)

30383 DETERMINATION OF HYDROGEN BY NEUTRON ACTIVATION ANALYSIS. Mednis, I. V. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 1, 11-18(1967). (In Russian).

A method was developed for the determination of hydrogen, using a fixed calibration plot. The method was tested on chemically pure substances. The sensitivity limit of the method was 10^{-7} g of hydrogen. (auth)

30384 SPECTROCHEMICAL ANALYSIS OF RADIOACTIVE SUBSTANCES. V. EFFECT OF THE ELECTRODE PROPERTIES ON THE ABSOLUTE SENSITIVITY OF THE ANALYSIS. Svoboda, V. (Inst. for Research, Production, and Use of Radioisotopes, Prague). Collect. Czech. Chem. Commun., 32: 1888-1902(May 1967).

The effect of electrode properties on the absolute sensitivity of the spectrochemical analysis was investigated in cases, where the sample is fixed on the surface of the electrode in the form of an evaporated residue. (auth)

30385 SIMULTANEOUS ^{3}H AND ^{14}C ASSAY IN A 2π WINDOWLESS FLOW PROPORTIONAL COUNTER. Tykva, R. (Inst. of Organic Chemistry and Biochemistry, Prague). Collect. Czech. Chem. Commun., 32: 2001-3(May 1967).

A procedure for the simultaneous determination of ^{3}H and ^{14}C is described that makes use of the different amplitude spectra of impulses evoked in a 2π windowless flow proportional counter by the two radionuclides. The estimation can be carried out in a single operation and the detection efficiency for ^{14}C disintegrations is increased radically. Higher ^{14}C activity can be measured without correction for the so-called dead time. The method can be used with residues on planchets, with samples on membrane filters, or with paper or thin-layer chromatography. The attainable detection sensitivity of both radionuclides in a simultaneous determination was higher in the method described than in liquid scintillation. In comparison with the method using an internal gas counter the sensitivity of detecting tritium in samples prepared in an infinitely thin layer was about three times greater, while with respect to ^{14}C it was about equal. The preparation of the sample for measurement and the measuring equipment are simpler, but the application of the method described is limited by the character and the amount of samples to be counted. (D.H.M.)

30386 DETERMINATION OF FISSION PRODUCT ACTIVITIES IN GRAPHITE BY GAMMA SPECTROMETRY. Paul, H. (Oesterreichische Studiengesellschaft fuer Atomenergie, Seibersdorf, Austria); Blomstrand, J. H. J. Nucl. Energy, 21: 183-91(Feb. 1967).

A nondestructive technique is described for quantitative routine determination of radioactive fission and neutron-activation products in graphite. The method is based on scintillation spectrometry and computer analysis of the γ spectra. Graphite samples from Dragon loop experiments were analysed, and results agree with figures obtained by radiochemical analysis of similar samples. The methods were applied for the determination of axial and radial distributions of fission products in graphite fuel tubes. (auth)

30387 DETECTION OF GASES ENTRAINED IN SODIUM AT FREE SURFACES. Lions, N. (CEN, Cadarache, France). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-85/5, 24p. (In French). (CONF-661110-26). DTIE.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna.

A method for measuring the gas volume fraction in a homogeneous two-phase flow with two constituents is presented. The principle employed is based on measurement of the speed of sound in a flow. For a flow with two given constituents, the latter value is a function of temperature, static pressure, gas volume fraction, and average radius of the gas voids. With the exception of the gas fraction and the average radius these parameters can be measured directly. When the average radius exceeds a threshold r_m, the speed of sound varies with the static pressure. Use is made of this phenomenon by carrying out sound-velocity measurements in the flow of two different static pressures. This provides information on the order of magnitude of the average radius of the gas voids as well as the gas volume fraction. With this method it is possible to determine the volume fraction in the 10^{-4} to 5×10^{-2} range of gas voids with an average radius of $r_m > 10^{-5}$ mm. Experimental results are presented for water–Ar and Na–Ar flows in horizontal geometries, and a discussion of the equipment used to measure the gas fraction in the central channel of the Rapsodie core is presented. (auth)

30388 DETERMINATION OF SMALL QUANTITIES OF OXYGEN, HYDROGEN, AND CARBON IN SODIUM. Sannier, J.; Champeix, L. (CEN, Saclay, France). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-85/8, 16p. (In French). (CONF-661110-29). DTIE.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna.

An apparatus is described for determination of trace amounts (<10 ppM) of O_2 in Na by vacuum amalgamation. The apparatus is designed to eliminate the fixation of O_2 by Hg in the presence of air and the contact between the Na and the tap grease. The Hg is filled into the apparatus by vacuum distillation and the entire column can be oven dried to completely eliminate traces of moisture. The amalgam extraction operation is performed by siphoning under a constant Hg flow without external manipulation. The dissolved H_2 or H_2 present in the Na as the hydride is determined by quantitative gas chromatographic analysis of the gases released during the residue-hydrolysis and amalgamation operations, and the sensitivity of the method is 0.1 ppM. The H_2 present as the hydroxide is determined by vacuum heating the Na at 320°C and determining the H_2 released in accordance with the reactions: $2\ Na + NaOH \rightarrow Na_2O + NaH$ and $NaH \rightarrow Na + \frac{1}{2}H_2$. The accuracy of this determination is in the ppM range. Only one Na sample is necessary for the determination of uncombined C, carbonates, and carbides. The uncombined C is determined under vacuum by oxidation with Van Slyke's mixture followed by a gas-chromatographic check of the purity of the CO_2. The sensitivity is about 5 ppM. The Na is then reacted with acidified H_2O and any CO_2, acetylene, and other hydrocarbons formed are collected and analyzed by gas chromatography. (auth)

30389 EXPERIENCE WITH IMPURITIES IN A LARGE SODIUM CIRCUIT. Fielder, E. A.; Hamer, A. N.; Higson, J.; Jennings, T. E.; Trevalion, P. A. (United Kingdom Atomic Energy Authority, Risley, Eng.). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-85/14, 24p. (CONF-661110-21). DTIE.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna.

Information was gained on impurity control in sodium from several large experimental rigs ranging in size from 5 to 500 ft^3 capacity and operating at temperatures between 300 and 650°C. The rigs, built for testing reactor components, are similar to reactor cooling systems in material, methods of construction, and geometry. Results of the investigation are therefore applicable to reactor design. The main impurities considered are O_2, H_2, Ca, and C. It is postulated that these impurities enter the system through the Na manufacturing process, as contamination in construction materials and cover gas, and by handling operations. The amounts attributable to each of these routes were estimated by chemical analysis of the Na, steels, and cover gases to provide a prediction of the final impurity level of the Na charge. This predicted figure is compared with the amounts of impurity that actually entered the rigs as determined by regular sampling of the Na during rig commissioning. Specially developed sampling equipment and techniques were used and these are described. The effect on the principal impurities of changing temperature conditions is assessed. Evidence of the formation of CaO and NaOH during initial high-temperature work is reported, and their effect on operations is discussed. The performances of the rig cold traps, which are extensively instrumented, and filter units were measured. The results from different types of plugging meters were compared with Na sample analysis. (auth)

Inorganic, Organic, and Physical Chemistry

Refer also to abstract 30448.

30390 (AGN-8222) ALKALI METALS EVALUATION PROGRAM. Quarterly Progress Report, January 1–March 31, 1967. Achener, P. Y. (Aerojet-General Corp., San Ramon, Calif. Nuclear Products and Services Group). May 1967. Contract AT(04-3)-368. 30p. Dep. CFSTI.

Developments in studies on the thermodynamic and transport properties of Rb, Cs, and K and thermodynamic and transport properties of alkali metals for heat pipe applications are described. Data are given on: PVT relations for K; vapor thermal conductivity of Rb; liquid viscosity of Li; and liquid thermal conductivity of Li and Na. (P.C.H.)

30391 (CEA-R-3198) PROCEDE CONTINU DE PRECIPITATION DES SELS DE PLUTONIUM. (Continuous Precipitation Process of Plutonium Salts). Richard, Pierre (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Mar. 1967. 90p. (In French). Dep.

Continuous precipitation processes for plutonium oxalate are described. Investigations on the solubility of different valence states in nitric–oxalic and in nitric–sulfuric–oxalic acid media were used to select the precipitation process for tetravalent plutonium oxalate. Settling velocity and granulometry of tetravalent plutonium oxalate have been studied with variation of several precipitation parameters such as: temperature, acidity, excess of oxalic acid, and aging time. Test results are given for some continuous laboratory equipment. Conditions of operation for adopted tubular apparatus are defined. A flowsheet is given for a process on an industrial scale. (auth)

30392 (CEA-R-3207) ETUDE DU SOLVANT PHOSPHATE TRIBUTYLIQUE 30 PERCENT–DODECANE. (Study of the Tributyl Phosphate–30 Percent Dodecane Solvent). Leroy, Paul (Commissariat a l'Energie Atomique, Fontenay-aux-Roses. Centre d'Etudes Nucleaires). Mar. 1967. 160p. (In French). Dep.

The principal chemical and physical features of the tributylphosphate (TBP) agent diluted at 30 volume per cent in dodecane are reviewed. The mixture is a very commonly used extractant in nuclear fuel processing. The topics discussed include: the components (TBP and diluents); TBP–diluents systems (nonloaded); TBP–diluents–water systems; TBP–diluent–water–nitric acid systems; and industrial solvent. (121 references). (auth)

30393 (COO-1001-14) THE EFFECTS OF POLYFUNCTIONAL ANIONS ON ELECTRON TRANSFER BETWEEN METAL IONS IN SOLUTION. Report of Progress, 1966–1967. Brubaker, Carl H. Jr. (Michigan State Univ., East Lansing. Dept. of Chemistry). May 15, 1967. Contract AT(11-1)-1001. 10p. Dep. CFSTI.

Developments are reported for studies on oxidation-reduction reactions involving tris(1,10-phenanthroline)iron(II) and related compounds as reducing agents for thallium(III) and peroxydisulfate ions and on the nature and mechanisms of formation and decomposition of molecular oxygen carriers. Preliminary results are also reported for studies on the photochemical acceleration of the electron exchange reaction between U(IV) and uranyl ions. (P.C.H.)

30394 (IS-T-101) AN ANALYTICAL TREATMENT OF IONIZATION EFFICIENCY DATA FOR XENON FROM A PULSED RETARDING-POTENTIAL ION SOURCE. Sparrow, Gene Rodell (Ames Lab., Iowa). Aug. 1966. Contract W-7405-eng-82. 226p. Dep. CFSTI.

Thesis.

A mass indicator based on the Hall effect and the use of a Hall crystal to regulate the magnetic field for mass spectral scans are described. A mass spectrometer with a versatile ion source that is capable of being used in any of several conventional or retarding modes of operation, with or without pulsing techniques, for obtaining precise electron–bombardment ionization efficiency data is discussed. A differential voltmeter readout system permits rapid recording of data directly on computer coding forms. Several computer techniques are applied in order to obtain more precise and meaningful appearance potentials. Some of the data were subjected to extensive mathematical treatment involving a Maxwellian electron thermal-energy distribution and Gryzinski's cross-section equations for ionization. Careful application of a computer plotting technique and superpositioning of several ionization efficiency curves of Xe^+, obtained using only a retarding potential (not the difference technique), revealed some of the lower autoionization states of Xe^+. It is also shown that careful account of the effects of instrumental conditions on the observed appearance potential can be used to calibrate the energy scale very precisely. The major corrections are due to the repeller and anode gradients, and the effect of the retarding potential on the average electron thermal energy. Contact potentials were insignificant over a wide range of conditions. (auth)

30395 (IS-T-150) INVESTIGATIONS OF SOME METHODS FOR PREPARING THORIUM CHLORIDE. Bergman, Roger Michael (Ames Lab., Iowa). Feb. 1967. Contract W-7405-eng-82. 122p. Dep. CFSTI.

Thesis.

Several approaches toward $ThCl_4$ preparation were investigated and the results are reported. In exploratory investigations, a variety of thorium source materials and chlorinating agents were studied. Considering the relative reactivities of thorium compounds toward chlorination, it was found that the oxalate was the most readily chlorinated of those compounds that were investigated. Low-fired oxide was next in order and the nitrate, sulfate, and high-fired oxide were found to be very difficult to chlorinate under the conditions employed. Chlorinating agents investigated included: chlorine alone; systems based on carbon tetrachloride, i.e., $CO_2 + CCl_4$, $Cl_2 + CCl_4$, and $He + CCl_4$; chlorine plus sulfur chlorides; and variations of a carbon plus chlorine approach. On the basis of the results of the preliminary investigations, the chlorination of thorium oxalate with mixtures of CO_2 and CCl_4 was selected for a more detailed study. In the present state of development, a charge of thorium oxalate is chlorinated in a fixed bed type reactor with approximately 1:1 mole mixtures of CO_2 and CCl_4. The reaction temperature is raised from 300 to 610°C in the course of the reaction which takes from 5 to 6 hours. Analytical data indicate that the product is approximately 99.4% tetrachloride (less than 0.08% oxygen). Batches as large as ¾ pound have been prepared by this technique. In order to further evaluate the quality of the tetrachloride and to demonstrate that this chloride is of acceptable quality for metal preparation, magnesium reductions were made. The thorium obtained from these reductions was arc melted to yield good quality metal. Analytical results indicated oxygen contamination of about 925 ppM, carbon 27 ppM, and only about 3 ppM nitrogen. The Vickers hardness number of this thorium was about 38 to 44 as arc melted and 33 to 36 after annealing. This quality of metal is equivalent to that obtained from chloride prepared by other methods involving one or more intermediate purification steps. Therefore, it appears that the direct preparation of thorium tetrachloride by this CO_2-CCl_4 process has significant advantages over other processes that have been employed for preparing the tetrachloride. (60 references.) (P.C.H.)

30396 (IS-T-168) THE CRYSTAL STRUCTURE DETERMINATIONS OF $Cu_5Cl_{10}(C_3H_7OH)_2$, $DyCl_3.6H_2O$ AND $Ag(P(OCH_2)_3CCH_3)_4ClO_4$. Ugro, Josef Vendal Jr. (Ames Lab., Iowa). May 1967. Contract W-7405-eng-82. 87p. DTIE.

Thesis.

The results of single crystal x-ray diffraction studies on $Cu_5Cl_{10}(C_3H_7OH)_2$, $DyCl_3 \cdot 6H_2O$, and $Ag(P(OCH_2)_3CCH_3)_4ClO_4$, silver perchlorate complex with 4-methyl-2,6,7-trioxa-1-phosphabicyclo-[2.2.2]-octane, are reported. The compound $Cu_5Cl_{10}(C_3H_7OH)_2$ crystallizes in the monoclinic system with space group $P2_1/c$, lattice constants a = 10.244 ± .007, b = 6.025 ± .008, c = 20.41 ± .015 Å, β = 115.48 ± .03°, and z = 2. The crystals consist of an interlacing of essentially planar copper–chlorine bridge networks, each of which have the above formula. The propanol groups are attached to the terminal copper atoms and are located trans with respect to each other. The planar networks are held together by long copper to chlorine bonds of 2.68 and 2.69 Å. The central copper in each unit has a square planar configuration, while the remaining coppers are five coordinate with a square pyramidal configuration. The compound $DyCl_3 \cdot 6H_2O$ crystallizes in the monoclinic system with space group P2/n, lattice constants a = 7.868 ± .003, b = 6.491 ± .003, c = 9.596 ± .004 Å, β = 93.69 ± .02°, and z = 2. The formula for this compound should be written $[Dy(H_2O)_6Cl_2]^+Cl^-$, the metal ion having an eight membered coordination sphere. The atoms in this coordination sphere are arranged in a distorted dodecahedron with triangular faces. There appears to be a strong possibility that hydrogen bonding occurs between water oxygens within the coordination sphere. The result of a joint structure determination on $HoCl_3 \cdot 6H_2O$ is presented for completeness. A comparison of the structures of the isostructural compounds $EuCl_3 \cdot 6H_2O$, $GdCl_3 \cdot 6H_2O$, $DyCl_3 \cdot 6H_2O$ and $HoCl_3 \cdot 6H_2O$ is given. The compound $Ag(P(OCH_2)_3CCH_3)_4ClO_4$ crystallizes in the tetragonal system with space group $I4_1/a$, lattice constants a = b = 11.757 ± .003, c = 23.624 ± .006 Å, and z = 4. The ligands are arranged in a regular tetrahedron about the silver ion, with a Ag–P distance of 2.436 Å indicating strong $d\pi$–$d\pi$ back bonding. The ligand has a cage structure of the triane type. (auth)

30397 (NASA-TN-D-3992) KINETICS OF THE FLUORINATION OF BERYLLIUM. O'Donnell, Patricia M. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). July 1967. 12p. CFSTI.

The kinetics of the reaction of sheet beryllium and gaseous fluorine to form beryllium fluoride were studied by means of the pressure-drop method over the temperature range from 125 to 775°C and at pressures from 20 to 700 torr. The reaction followed the parabolic rate law $y^2 = kt$, where y is the amount of fluorine consumed per unit area of beryllium surface (ml/cm^2), k is the parabolic rate constant, and t is the time (min). Parabolic rate constants were calculated, and activation energies are given. A change of slope in the plot of the rate constant against reciprocal temperature suggests a change in the nature of the reaction near 525°C. Above 525°C the crystal structure of the film changes from α-quartz hexagonal to rhombic tridymite. Beryllium is identified as the diffusing species. (auth)

30398 (NP-16813) INTERPRETATION OF THE OPTICAL SPECTRUM OF Yb^{3+} IN CdF_2. Technical Report No. 2. Abbruscato, Victor J. (Polytechnic Inst. of Brooklyn, N. Y.). June 1967. Contract DA-31-124-ARO(D)-71. 81p.

Thesis.

The optical absorption spectra of Yb^{3+} in CdF_2 and of Yb^{3+} in CdF_2 in the presence of various co-dopants such as Na^+, Y^{3+}, and Eu^{3+} were recorded and the oscillator strengths of the main absorptions of the Yb^{3+} in the 10,000 cm^{-1} region were calculated. Also, the electron spin resonance (ESR) spectra of Yb^{3+} in CdF_2 and Yb^{3+} in CdF_2 in the presence of Na^+, 2% Y^{3+}, and 10% Y^{3+} were recorded. Non-cubic spectra were observed only in the case of the $Yb^{3+}-Na^+-CdF_2$ and $Yb^{3+}-10\%\ Y^{3+}-CdF_2$ samples. The former non-cubic spectrum was interpreted assuming a rhombic distortion with the major distortion axis along the [110] direction, while the latter could not be interpreted due to the broadness of the absorptions. From the results of these measurements and the comparison to the optical spectra of Yb^{3+} in other systems, it has been concluded that the previous interpretation of the optical spectrum of Yb^{3+} in CdF_2 is incorrect. It is contended that the main absorption line at 10,250 cm^{-1} is not due to an internal f-f transition but is due to some other mechanism. Possible mechanisms are proposed based on some of the unusual physical properties of trivalent rare earth ions in CdF_2. (auth)

30399 (ORNL-TM-1893) DIELECTRIC CONSTANTS AND REFRACTIVE INDICES OF SOLUTIONS OF SOME ORGANOPHOSPHORUS COMPOUNDS IN n-OCTANE. McDowell, W. J. (Oak Ridge National Lab., Tenn.). June 13, 1967. Contract W-7405-eng-26. 5p. Dep. CFSTI.

Dielectric constant and refractive index data are presented for n-octane solutions of several high molecular weight organophosphorus compounds used in solvent extraction systems. Dielectric constant data are included for di(2-ethylhexyl)phosphoric acid (HDEHP), its sodium and strontium salts (and complexes of these salts with additional acid), for tri-n-butylphosphate (TBP), tri-n-octyl-phosphine oxide (TOPO), and mixtures of these neutral organophosphorus compounds with HDEHP, its salts and complexes. Refractive indexes of HDEHP, TBP, $Sr(DEHP)_2$, NaDEHP · 3 HDEHP, and TOPO solutions are included. (auth)

30400 (UCLA-34P13-22) FLUOROCARBON SOLUTIONS. Final Report. Scott, Robert L. (California Univ., Los Angeles. Dept. of Chemistry). Feb. 1967. Contract AT(11-1)-34. 14p. Dep. CFSTI.

Vapor pressures of fluorocarbon solutions at low temperature, liquid-liquid phase diagrams, heats of mixing, volume changes on mixing, solubility of solids, second virial coefficients, lower critical solution temperatures, gas chromatography, effects of centrifugal fields on liquid miscibility, hydrogen bonding, and theoretical and interpretative studies are discussed. (M.C.G.)

30401 (UCRL-17330) INORGANIC MATERIALS RESEARCH DIVISION ANNUAL REPORT, 1966. (California Univ., Berkeley. Lawrence Radiation Lab.). Mar. 1967. Contract W-7405-eng-48. 200p. Dep. CFSTI.

Four sections on chemistry, metallurgy, ceramic science, and solid state physics are included; separate abstracts were prepared for three. The remaining section on solid state physics contains information on research plans for the calendar year 1967. (P.C.H.)

For abstracts of individual sections see: 30402, 31036, and 31089.

30402 (UCRL-17330, pp 1-78) CHEMISTRY. (California Univ., Berkeley. Lawrence Radiation Lab.).

Developments are reported for studies in: inorganic chemistry; chemical thermodynamics; solid-state chemistry and physics; electrochemistry; physical chemistry; and nuclear science. Separate studies within each category are described briefly. (P.C.H.)

30403 (UCRL-17480) RESPONSE MODE ANALYSIS AND CONTROL OF MULTIVARIABLE CHEMICAL PROCESSES: APPLICATION TO DISTILLATION. Levy, Robert Edward (California Univ., Berkeley. Lawrence Radiation Lab.). June 1967. Contract W-7405-eng-48. 320p. Dep. CFSTI.

Thesis.

The natural modes of a multivariable process may serve as the framework for a feedback control scheme that hastens the response of the process, overcomes the problem of control loop interaction, and guides the selection and interconnection of measured and manipulated variables. The independent modes of a simulated binary distillation column were identified, and their significance and physical basis evaluated. This provides information necessary for the development of modal controllers. Distillation modes were determined from three different mathematical models, the most comprehensive of which includes unsteady balances for mass, chemical species, and enthalpy. The accurate computation of modes for the large unsymmetric matrices generated by the models requires efficient numerical procedures, such as the QR algorithm for eigenvalues and an inverse iteration scheme for eigenvectors. The dominant, or most slowly decaying, mode were associated with compositions throughout the column, but not with enthalpy or mass accumulation. It was highly activated by all inputs to the column. The second slowest mode, which has a characteristic decay time 2.5 times shorter than the slowest, can be identified with the accumulator. The effects of various design and operating conditions on the modes were evaluated. A sensitivity analysis revealed those distillation parameters whose values influence the slow modes most strongly. The limitations of modal control caused by partial observability and partial controllability were examined. A modal controller was developed by approximate methods for the slowest mode of the column. It decreased the process response time by a factor of 2.5 and caused very little alteration of the faster modes. A feedforward controller that detects disturbance inputs and cancels the activations of the three slowest modes was also investigated. The influence of these disturbances can be reduced by an order of magnitude in this way. (auth)

30404 (UCRL-50260) CONTRACTED BASIS SET ANALYTIC SELF-CONSISTENT FIELD WAVE FUNCTIONS FOR TRANSITION METAL ATOMS. Karo, A. M.; McMurphy, F.; Nesbet, R. K. (California Univ., Livermore. Lawrence Radiation Lab.). May 17, 1967. Contract W-7405-eng-48. 28p. Dep. CFSTI.

Self-consistent field wave functions for transition metal atoms in their neutral ground state configurations were obtained that are close approximations to conventional, restricted Hartree-Fock functions. The atomic orbitals were expanded in terms of linear combinations of orbitals from a basis set of eleven exponential Slater-type functions. Both the linear expansion coefficients and the nonlinear exponential parameters were optimized by means of standard variational procedures. The results showed that from 80 to 90% of the energy improvement between simple Slater orbitals with nonoptimized screening parameters and the true Hartree-Fock results is obtained through this limited, optimized basis. (auth)

30405 (ORNL-tr-1714) COLLOIDAL THORIUM. Translated by R. G. Mansfield (Oak Ridge National Lab., Tenn.), from pp 92 of Gmelin's Handbook of Inorganic Chemistry, 8th Edition, Verlag Chemie Weinheim Bergstresse, 1955. 3p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

The preparation and properties of colloidal thorium are briefly discussed. (P.C.H.)

30406 CONTRIBUTION OF MICROCALORIMETRY TO THE STUDY OF SOME FUNDAMENTAL FEATURES OF THE STRUCTURE OF MATTER. Guarini, G. (CISE, Milan). Energ. Nucl. (Milan), 14: 306-17(May 1967). (In Italian).

The basic methods of modern microcalorimetry are summarized and some fundamental results are considered; the recent progress of microcalorimetry is not to be ascribed to the discovery of new principles but to the employment of more advanced thermometric techniques, automatic controls, and to the use of a number of ingenious solutions. (auth)

30407 THE PARTICIPATION OF SOLVENT AND GENERAL ACIDS IN ACETAL HYDROLYSIS. THE HYDROLYSIS OF 2-(para-SUBSTITUTED PHENYL)-4,4,5,5-TETRAMETHYL-1,3-DIOXOLANES. Fife, Thomas H. (Univ. of Southern California, Los Angeles). J. Amer. Chem. Soc., 89: 3228-31(June 21, 1967).

The hydrolysis of 2-phenyl-4,4,5,5-tetramethyl-1,3-dioxolane in 0.100 M HCl is characterized by a ΔS^* of −14.2 eu and a D_2O solvent isotope effect of $k_D/k_H = 2.4$. The value of ρ for hydrolysis of a series of 2-(para-substituted phenyl)-4,4,5,5-tetramethyl-1,3-dioxolanes in 0.100 M HCl at 30° was found to be −2.0. The values of ΔS^* and k_D/k_H are considerably less than normally found in

acetal hydrolysis while the ρ value is much more positive than found previously for hydrolysis of the diethyl acetals of meta- and para-substituted benzaldehydes. The rate constants for hydrolysis of 2-(p-nitrophenyl)-4,4,5,5-tetramethyl-1,3-dioxolane in moderately concentrated HCl solutions are proportional to the stoichiometric acid concentration while a plot of log k_{obsd} vs $-H_0$ shows a pronounced downward curvature. The slope w of a plot of log k_{obsd} + H_0 vs the logarithms of the activity of water is +1.9. Thus the evidence supports the incursion of an A2 mechanism involving attack of water on the protonated substrate. The rate of hydrolysis of 2-(p-methoxyphenyl)-4,4,5,5-tetramethyl-1,3-dioxolane is subject to catalysis by increasing concentrations of formic acid at constant pH and ionic strength. (auth)

30408 ARYLATION BY AROMATIC NITRO COMPOUNDS AT HIGH TEMPERATURES. II. NITROBENZENE ALONE AND WITH BENZENE AND BENZENE-d_6. Fields, Ellis K. (Amoco Chemicals Corp., Whiting, Ind.); Meyerson, Seymour. J. Amer. Chem. Soc., 89: 3224-8(June 21, 1967).

The nitroarene bond in nitrobenzene and other aromatic nitro compounds breaks above 400°; this provides an easy means of generating phenyl and a great many other aromatic radicals. The decomposition of nitrobenzene alone at 600° seems to parallel rather closely its decomposition under electron impact in the mass spectrometer. With benzene and benzene-d_6, nitrobenzene yielded mainly biphenyl and terphenyl and their deuterated analogs, respectively. Higher yields than calculated on the basis of only one radical indicated the involvement of the NO_2 portion of the original nitrobenzene. (auth)

30409 BIS(PYRIDINE)BORONIUM SALTS. SYNTHESES AND FORMATION KINETICS. Ryschkewitsch, G. E. (Univ. of Florida, Gainesville). J. Amer. Chem. Soc., 89: 3145-8(June 21, 1967).

Salts of bis(pyridine)boronium ion even synthesized in pyridine by four routes: from trimethylamine borane and iodine, from trimethylamine borane and bis(pyridine)mercury(II) chloride, from from sodium borohydride,and iodine, and from trimethylamine chloroborane. In addition, the B-deuterated ion was prepared. The reaction between trimethylamine borane and iodine exhibited a deuterium isotope effect, which was established from competitive rates and from the reaction rates of the hydrogen and deuterium compounds ($k_H/k_D = 2.0$). A reaction mechanism is discussed. (auth)

30410 INVERSION OF POSITIONAL REACTIVITY ORDER AND TWO MECHANISMS OF HYDROGEN–DEUTERIUM EXCHANGE FOR PYRIDINE. Zoltewicz, John A.; Smith, Craig L. (Univ. of Florida, Gainesville). J. Amer. Chem. Soc., 89: 3358-9(June 21, 1967).

Hydrogen–deuterium exchange was studied in pyridine in deuterated hydrochloric acid, sodium hydroxide, and water solutions. Results point to an inversion in the relative positional reactivity order in aqueous solutions. Two exchange mechanisms are suggested. (J.G.B.)

30411 OVERALL PROTIUM-TRITIUM KINETIC ISOTOPE EFFECT IN THE ALCOHOLYSIS OF TRI-n-OCTYLALUMINUM. Kohn, Erwin (Southwestern State Coll., Weatherford, Okla.); Gill, Jack M. J. Organometal. Chem. (Amsterdam), 7: 359-62(Feb. 1967).

The overall protium-tritium isotope effect was determined in the alcoholysis of trialkyl aluminum, as well as the variation of the effect with temperature. The results showed that, particularly with isobutyl alcohol, the magnitude of the kinetic isotope effect varied markedly as the temperature changed. The data suggest cautious use of kinetic isotope effect values, unless the experimental temperatures are well defined. The alcoholyses were carried out at several temperatures with tri-n-octylaluminum and methanol or isobutyl alcohol containing a trace of tritium in the labile position. The hydrocarbon product was isolated, radioassayed, and the overall kinetic isotope effect, k_H/k_T, was determined from a comparison with the radioassay of the alcohol used. Arrhenius-type plots of k_H/k_T are shown. The value of k_H/k_T varied for methanol from 2.87 at 0°C to 2.31 at 46°C and for isobutyl alcohol from 7.82 at 0°C to 1.76 at 104°C. (BBB)

30412 BEHAVIOR OF URANYL IN SULFIDE SOLUTIONS AT pH 10. La Ginestra, Aldo; Ancarani-Rossiello, Laura; Giacci, Marco (CNEN, Rome). Gazz. Chim. Ital., 96: 1599-1608(1966). (In Italian).

Changes in the uranyl ion (10^{-3} M) in solutions containing the sulfide ion at pH 10 were studied by fluorescence and absorption spectra and electrophoretic tests. Uranium (VI) was not reduced by sulfide and hydrolyzed very slowly, giving different fluorescence spectra from other known complexes or hydrolyzed compounds. It is suggested that some partial replacement of OH^- with SH^- may occur in the sphere of uranyl ligands and that the new compounds formed consequently have a lower hydrolysis rate. (BBB)

30413 ACTION OF ALKALINE SULFIDES TO SOLUTIONS OF URANYL SALTS AT VARIOUS pH. La Ginestra, Aldo; Marucci, Giuseppe; Stampacchia, Giuseppe (CNEN, Rome). Gazz. Chim. Ital., 96: 1589-98(1966). (In Italian).

Changes in the absorption spectrum in the uv range were studied after the addition of alkaline sulfides (Na_2S, NaHS) to uranyl solutions ($\leq 10^{-3}$ M) in the pH range 6 to 12. Only in the pH range 6 to 9 were reduction to U(IV) and subsequent hydrolysis found to occur; around pH 10 the U remained in solution as U(IV) for a long time and only very slowly hydrolyzed. Also, at a pH greater than 10.5 the U was not reduced, but more rapidly hydrolyzed and precipitated as uranate. For uranyl carbonate solutions, similar phenomena were observed. The presence of sulfides slowed down the formation of uranates at pH values greater than 9.5. These results were based on absorption spectra, electrophoretic tests, and variations of pH with time. (BBB)

30414 MASS-SPECTROMETRIC STUDY OF THE REACTIONS OF DEUTERIUM AND HYDROGEN ATOMS WITH NITRIC OXIDE. Kohout, F. C.; Lampe, F. W. (Pennsylvania State Univ., University Park). J. Chem. Phys., 46: 4075-84(May 15, 1967).

The details of the reactions of deuterium and hydrogen atoms with nitric oxide in D_2–NO and H_2–NO mixtures (less than 1% NO) were studied by a mass-spectrometric method. Nitroxyl was produced as the primary product and rapidly attained a steady-state concentration. Further reaction of nitroxyl with nitroxyl produced nitrous oxide and water with a rate constant of $6.7 \pm 2.2 \times 10^{-16}$ cm^3 $molecule^{-1} \cdot sec^{-1}$. The reaction of nitroxyl with hydrogen atoms produced small amounts of hydroxylamine, and proceeded, at the highest pressure employed (70 torr), with a rate about $1/_{10}$ of the rate of formation of nitrous oxide. From considerations of the effect of total pressure on the steady-state level of nitroxyl, the rate constant for the deuterium-atom abstraction of deuterium from DNO was estimated to lie between 10^{-13} and 10^{-12} cm^3 $molecule^{-1} \cdot sec^{-1}$. The vessel surfaces played no part in the reaction, other than to adsorb the products, water and hydroxylamine. (auth)

30415 STUDIES ON THE KINETICS AND THE MECHANISM OF DEUTERIUM BASIC EXCHANGE OF THE METHYL DERIVATIVES OF SOME NITROGEN-CONTAINING HETEROCYCLES AND TERTIARY SALTS IN ALCOHOLIC MEDIUM. Zatsepina, N. N.; Tupitsyn, I. F. Isotopenpraxis, 3: 104-9(Mar. 1967). (In Russian).

The rate constants of hydrogen isotopic exchange in the $-C-CH_3$ group were measured for the exchange reactions of 1- and 2-methylnaphthalene, 2-, 4-, 6-, 8-methylquinoline, 2,4- and 2,6-dimethylquinoline in alcoholic solution of potassium ethylate. The rate constants of the $N-CH_2$ group exchange reaction were determined for the iodine methylates of pyridine, 2-, 3-, 4-picoline, γ,γ'-dipyridyl, dimethylaniline, α-picoline-N-oxide and 6-methylquinoline-N-oxide in an alcoholic solution of trimethylamine. The mechanism of deuterium exchange is discussed. (auth)

30416 STEREOCHEMISTRY AND KINETIC ISOTOPE EFFECTS IN THE FORMOLYTIC REARRANGEMENT, SUBSTITUTION, AND ELIMINATION REACTIONS OF ANDROSTERONE p-TOLUENESULFONATE. Ramseyer, Judith; Hirschmann, H. (Western Reserve Univ., Cleveland. University Hospitals, Cleveland). J. Org. Chem., 32: 1850-9(June 1967).

The formolysis of 3α-p-toluenesulfonoxy-5α-androstan-17-one gave mainly 5α-androst-2-en-17-one and lesser amounts of the Δ^3 isomer and of the formates of 3β-, 2β-, 3α-, and (in traces) 2α-hydroxy-5α-androstan-17-one. The four formates are listed in the declining order of their yields after correction for the slow addition of formic acid to the olefin, which gave mainly the 3α and 2β, some of the 2α, and traces of the 3β isomers. The rearrangement of the 3α-tosylate to the 2β-formate proceeds in part (about 20%) via the 2α-tosylate, which was isolated after an incomplete reaction. The formolysis of the latter was 0.35 times as fast as that of androsterone tosylate and gave, beside olefins, the 2β-formate. The 2β-tritiated androsterone tosylate lost less tritium on formolysis (6%) than the 2α-tritiated analog (23%). This indicates that the elimination reaction of the (axial) 3α-tosylate was predominantly cis. Its rearrangement to the 2β-formate, however, proceeds mainly by the migration of the 2β-hydrogen. This unusual steric result, retention of configuration at C-2, is attributed to the shielding effect of the departing tosylate ion, since such a mechanism would also accommodate the lesser pathway to the 2β-formate via the 2α-tosylate. Kinetic isotope effects were calculated for the formation of the main reaction products. When the starting tosylate was axially tritiated at C-2, the 3β-formate showed an isotope effect, k_H/k_T, that was significantly lower than that for the disappearance of the tosylate or those for the formation of the 2β- and 3α-formates and of the mixture of olefins. The implications of

these results are compared with previously suggested schemes for the solvolysis of cis-4-t-butylcyclohexyl tosylate. In the additions of formic and of trifluoroacetic acid to the Δ^2-olefin, the entry of the nucleophilic agent was predominantly from the α side and thereby differed from the course of other ionic addition reactions of 5α-steroidal Δ^2-olefins. (auth)

30417 SUBSTITUENT EFFECTS ON SPECTRAL PROPERTIES AND HYDROGEN–DEUTERIUM EXCHANGE IN PROTONATED BENZOPHENONES. Eian, G. L.; Kingsbury, Charles A. (Iowa State Univ., Ames). J. Org. Chem., 32: 1864-6(June 1967).

Going from the ketone to protonated ketone involved extensive downfield shifts in the NMR. The chemical shifts of protons in ring A, the visible spectrum, and the exchange rates were all sensitive to the electron-donating character of substituents in ring B. Steric effects involving the coplanarity of the rings affected the spectra and exchange rates in the opposite manner. (auth)

30418 THE INFRARED SPECTRA OF BORAZINE AND ITS ISOTOPIC SPECIES. ASSIGNMENT OF THE a_2'' FUNDAMENTAL MODES. Kartha, V. B.; Krishnamachari, S. L. N. G.; Subramaniam, C. R. (Bhabha Atomic Research Centre, Trombay, Bombay, India). J. Mol. Spectros., 23: 149-57(June 1967).

The infrared spectra of borazine, ^{10}B-enriched borazine, B-deuteroborazine, and N-deuteroborazine are presented. Previous assignments for the a_2'' fundamental vibrational modes were shown to be unsatisfactory, from considerations of band contours, isotopic product rule, and solid state spectra. A revised assignment satisfying the above considerations is proposed. (auth)

30419 PROTON MAGNETIC RESONANCE SPECTRA OF THE MONOHALOBENZENES. Read, John M. Jr.; Goldstein, J. H. (Emory Univ., Atlanta). J. Mol. Spectros., 23: 179-90 (June 1967).

Theoretical analyses of the PMR spectra of chloro-, bromo-, and iodobenzene, with the aid of deuterium decoupled spectra of the para deutero derivatives of the chloro- and bromo-compounds, provided a complete set of spectral parameters for these compounds. Some surprisingly simple correlations were observed between the shifts and the couplings, and between each of these and other molecular parameters. In general these results do not appear to be explicable in terms of the existing theories of these parameters. (auth)

30420 NITRIDE FLUORIDES OF Th AND Zr. Juza, Robert; Sievers, Rolf; Jung, Walter (Univ., Kiel). Naturwissenschaften, 53: 551(1966). (In German).

Thorium fluoride, ThF_4, at temperatures from 850 to 1,100°C in an ammonia current was transformed into the nitride fluoride ThNF, which had the rhombohedral lattice constants a = 7.13 Å and α = 32.65°. In excess ThF_4 a second phase crystallized in a tetragonal form with the composition $ThN_{0.3}F_{1.3}$ with the lattice constants a = 4.06 Å, c = 5.86 Å, and c/a = 1.44 Å. A third rhombic phase $ThN_{0.8}F_{1.6}$ was obtained at lower N_2 content, with lattice constants of a = 4.15 Å, b = 4.02 Å, and c = 5.84 Å. Only one phase was obtained by heating ZrF_4 in the ammonia current. It crystallized in the tetragonal form with lattice constants a = 3.79 Å, c = 5.18 Å, and c/a = 1.37 Å, and was of the composition $ZrN_{0.91}F_{1.27}$. (J.S.R.)

30421 URANIUM NITRIDE BROMIDES AND URANIUM NITRIDE IODIDES. Juza, Robert; Meyer, Wolfgang (Univ., Kiel). Naturwissenschaften, 53: 552(1966). (In German).

UNBr and UNI were obtained by heating the tetrahelides in an ammonia current between 390 and 470°C. Both compounds crystallized in the tetragonal layer lattice of BiOCl, space group D_{4h}^7–P4/n mm with 2 formula units in the elementary cell. (M.C.G.)

30422 TETRAVALENT, PENTAVALENT, AND HEXAVALENT URANIUM COMPOUNDS OF THE TYPE $A_2BB'O_6$. Awasthi, S. K.; Chackraburtty, D. M.; Tondon, V. K. (Atomic Energy Establishment, Trombay, India). J. Inorg. Nucl. Chem., 29: 1225-8(May 1967).

The preparation and characterization of a number of compounds of the type $A_2BB'O_6$ where A = Ba, Sr, B = U(VI), U(V) or U(IV), and B' is a divalent, trivalent or tetravalent ion, respectively, were attempted. Most of the compounds were cubic, with an ordered perovskite structure, but the strontium compounds were pseudocubic, reindexable on an orthorhombic system. (auth)

30423 THE PROTACTINIUM(IV) HALIDES. Brown, D.; Jones, P. J. (Atomic Energy Research Establishment, Harwell, Eng.). J. Chem. Soc. (A), No. 5, 719-23(1967).

Protactinium tetrahalides, PaX_4 (X = Cl, Br, and I) were prepared by reduction of the corresponding pentahalides by either aluminium or hydrogen at 400 to 450°C. Protactinium tetrachloride and tetrabromide react with antimony trioxide at 200°C in a vacuum to form the oxydihalides, $PaOCl_3$ and $PaOBr_3$, respectively. A pink residue, which forms on sublimation of protactinium tetraiodide was identified, by x-ray powder diffraction analysis, as the oxydi-iodide, $PaOI_2$. Some chemical properties, visible spectra, and x-ray powder diffraction results are reported for these compounds, and for protactinium tetrafluoride, PaF_4. (auth)

30424 INFLUENCE OF THE ALKALI HALIDES ON THE STRUCTURE OF WATER. Greyson, J. (Atomics International, Canoga Park, Calif.). J. Phys. Chem., 71: 2210-13(June 1967).

Measurements of emf of electrochemical cells containing heavy and normal water solutions of several alkali halides were made. The cell potentials were combined with available heat of solution data to determine the entropy of transfer of the salts between the isotopic solvents. From the values of the entropy of transfer, the order of the structure-influencing properties of alkali cations and halide anions was found to be $K^+ > Na^+ > Li^+$ and $I^- > Br^- > Cl^- > F^-$. Differences in values among the ions indicated that structure-influencing properties are more sensitive to ion size for negatively charged species than for positively charged species. (auth)

30425 ^{13}C CHEMICAL SHIFTS OF THE CARBONYL GROUP. V. OBSERVATION OF A DEUTERIUM ISOTOPE EFFECT USING ^{13}C FIELD-FREQUENCY LOCK. Maciel, Gary E.; Ellis, Paul D.; Hofer, Donald C. (Univ. of California, Davis). J. Phys. Chem., 71: 2160-4(June 1967).

An isotope effect of −0.28 ppM on the ^{13}C chemical shift of the carbonyl group in acetone-d_6 with respect to that of acetone was observed. This result is discussed from a basic vibrational point of view and in the popular language of isotope substituent effects. A useful method for observing ^{13}C magnetic resonance spectra based on a direct ^{13}C field-frequency lock system is described. (auth)

30426 POLARIZATION OF MOLTEN ZINC CATHODE AT THE ELECTROLYSIS OF POTASSIUM AND SODIUM ZIRCONIUM-BEARING CHLORIDE MELTS. Volkovich, A. V.; Nichkov, I. F.; Raspopin, S. P. (Ural Polytechnic Inst., Sverdlovsk, USSR). Izv. Vyssh. Ucheb. Zaved., Tsvetn. Met., No. 2, 89-93 (1967). (In Russian).

The polarization of a liquid zinc cathode during electrolysis of potassium and sodium chloride melts was studied over the current density range of 10^{-4} to 2.10 a/cm^2, at 680 to 750°C, and with a zirconium content of 0.0, 0.1, 0.5, 0.96, 6.6, and 8.52 wt %. At cathode current density below 0.8 a/cm^2, zirconium on the zinc separated at 0.25 to 0.35 v higher potentials than on a solid molybdenum cathode. With a zirconium content exceeding 6 wt % and polarizing current exceeding 0.8 to 1.9 a/cm^2, the precipitation process in the liquid zinc is identical to the zirconium precipitation in a solid molybdenum cathode. The zirconium precipitation potential shifts to the more positive side with an increase of the temperature from 680 to 750°C. (R.V.J.)

30427 DETERMINATION OF LATENT HEAT OF FUSION OF ZIRCONIUM. Elyutin, V. P.; Maurakh, M. A.; Sverdlov, G. M. (Moscow Inst. of Steel and Alloys). Izv. Vyssh. Ucheb. Zaved., Tsvetn. Met., No. 2, 87-8(1967). (In Russian).

The description is given of a calorimeter used for determining the latent heat of fusion of zirconium using zirconium sponge (98.5% Zr) and iodide zirconium specimens. The tabulated data showed the latent heat of fusion of zirconium is equal to ±5 kcal/g atom. (R.V.J.)

30428 LOW-FREQUENCY RAMAN SPECTRA AND MOLECULAR ASSOCIATION IN LIQUID FORMIC AND ACETIC ACIDS. Waldstein, Peter; Blatz, L. A. (Los Alamos Scientific Lab., N. Mex.). J. Phys. Chem., 71: 2271-6(June 1967). (LA-DC-8384).

The low-frequency Raman spectra of normal and perdeuterated liquid formic and acetic acids and their solutions in water and hydrocarbons are reported. All the lines seen can be attributed to out-of-plane vibrations of various hydrogen-bonded associated species of the acids. Only lines assignable to cyclic dimers were observed in the hydrocarbon solutions. Glacial acetic acid also consists primarily of cyclic dimers. In anhydrous formic acid and in aqueous solutions of both acids, the predominant species is either an open dimer or a chain polymer. (auth)

30429 EMANATION-THERMAL STUDIES OF THORIUM FORMATE, ACETATE, PROPIONATE, AND BUTYRATE. Tetner, P.; Zaborenko, K. B. Vestn. Moskov. Univ., Ser. II, Khim., No 6, 54-8(Nov.-Dec. 1966). (In Russian).

The emanation method, based on determination of the high-temperature release of inert radioactive gases, such as radon, thoron, and actinon, from compounds containing the parent isotopes, was used for the study of some organic thorium salts. This method was applicable because radiothorium, ^{228}Th, is uniformly dis-

tributed in the system. The apparatus used made it possible to simultaneously record the α activity and to take differential-thermal-analysis, thermogravimetric, and dilatometric curves. All measurements were carried out while heating the specimens from room temperatures to 1200°C in an argon atmosphere; the activity of the thoron gas swept by argon was measured using an α scintillation counter. The decomposition of the salts and in the case of the formate, the loss of two molecules of water, are illustrated in the polythermic curves. The identical shape of the curves indicates that the process starting after decomposition is the same for all of the salts examined; thorium oxide was formed in every case. The "apparent emanation capacity" was found to be 60% at 1000°C for the formate but only 20% for the other 3 thorium salts. The oxide resulting from the decomposition of the formate was thus more finely dispersed than the material prepared from the other salts. Tests were also carried out to determine the emanation isotherms, i.e., the release of thoron at constant temperature as a function of time. These curves were found useful for examining the properties of the oxide. (TTT)

30430 HEAT OF FORMATION OF NIOBIUM BORIDES $NbB_{1.82}$ FROM NbB_2 PHASE. Reznitskii, L. A. Zh. Fiz. Khim., 41: 1160-2(May 1967). (In Russian).

Design and construction of a calorimeter for measuring the heat of boride chlorination reactions for the transition metals at 400°C are given. The heat of formation of niobium boride ($NbB_{1.82}$, $H_{f298°}$) was found to be 44.4 ± 4.5 kcal/mole. (R.V.J.)

30431 DETERMINING THE MELTING TEMPERATURES OF RARE-EARTH OXIDES. Mordovin, O. A.; Timofeeva, N. I.; Drozdova, L. N. Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 187-9(Jan. 1967). (In Russian).

The melting temperatures of several oxides of rare earths with atomic numbers from 67 to 71 (from La_2O_3 to Lu_2O_3) were determined. Oxide specimens, prepared by compacting powders of these compounds (99.0 to 99.93% purity) into rods 3 mm in dia and 10 to 20 mm long, were heated until a blob of molten material appeared at the end of specimen. The temperature at this point was considered to be the melting temperature. Results were plotted. With few exceptions, the melting temperature increased with an increase in atomic number. (ATD)

30432 REACTIONS OF URANIUM AND THORIUM CARBIDES WITH AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID AND SULFURIC ACID. Sears, Mildred Bradley; Ferris, L. M. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Inorg. Nucl. Chem., 29: 1548-52(June 1967). (ORNL-P-2834).

Reactions of uranium and thorium monocarbides at 80°C with 3 to 9 M HCl and 6 to 12 M H_2SO_4 yielded primarily methane, with no oxidation or formation of C–S, C–O–S, or C–Cl bonds. Examination of the gaseous products and waxes from reactions of the higher carbides with 3 to 9 M HCl and 6 M H_2SO_4 indicated that these reactions also were essentially hydrolysis reactions. While final conclusions cannot be drawn without examining all the nonvolatile products, it seems highly unlikely that there was any addition of HCl or H_2SO_4 to the $>C=C<$ groups, when no C–Cl, C–S, or C–O–S bonds were found in either the gaseous or the waxy components. Hydrochloric acid did affect the polymerization of the C_2 groups from the dicarbides; it increased polymerization to wax with uranium dicarbide and decreased polymerization (i.e., more gaseous hydrocarbons) with thorium dicarbide. The difference in the behavior of the two dicarbides may be related to the effect of hydrochloric acid on the reaction rates by decreasing the rate for uranium dicarbide, thus allowing more time for polymerization, and increasing the reaction rate for thorium dicarbide. Use of hydrochloric acid instead of water had little, if any, effect on the gaseous products from uranium sesquicarbide, probably because the oxidation of the uranium(III) in the carbide to uranium(IV) in the solution produces such a large excess of hydrogen. Results are compared with those of other workers. (auth)

30433 INTERNATIONAL SYMPOSIUM ON MACROMOLECULAR CHEMISTRY, PRAGUE, 1965. PART 2. Held Under the Auspices of the International Union of Pure and Applied Chemistry, Prague, August 30–September 4, 1965. J. Polym. Sci., Pt. C, No. 16, 621-1229(1967). (CONF-650801-(Pt.2)).

Fifty-one papers presented at the Symposium are given. A separate abstract was prepared for one paper. (M.C.G.)

For an abstract of the individual paper see: 30448.

30434 ONE-STEP METHOD OF CONVERTING URANIUM HEXAFLUORIDE TO URANIUM COMPOUNDS. Robinson, W. C.; Heestand, R. L.; Leitten, C. F. (to U. S. Atomic Energy Commission). U. S. Patent 3,331,666. July 18, 1967.

A method of making a uranium compound selected from uranium nitride, carbide, sulfide, silicide, or phosphide from uranium hexafluoride by mixing UF_6 and a gas containing nitrogen, carbon, sulfide, silicon, or phosphorus with an alkali metal vapor at a temperature of 800 to 1300°C and a pressure less than 25 torr (1 mm Hg) is described. (AEC)

30435 ELECTROLYTIC REDUCTION OF URANIUM HEXAFLUORIDE TO URANIUM METAL IN FUSED SALT. Piper, Roger D. (to U. S. Atomic Energy Commission). U. S. Patent 3,330,742. July 11, 1967.

Electrolytic reduction of uranium hexafluoride to uranium metal is accomplished by contacting the uranium hexafluoride with a carbon anode and a molten electrolyte containing uranium tetrafluoride and an alkaline earth fluoride and collecting the molten uranium metal at a cathode. (AEC)

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Refer also to abstracts 30486, 31060, 31110, 31118, and 31778.

30436 (AD-632704) RADIATION CHEMISTRY OF ALKYL HALIDES. Capellos, C. (Imperial Coll. of Science and Technology, London (England). Nuclear Technology Lab.). Jan. 1965. Contract AF 61(052)-456. 249p. (ARL-65-157). CFSTI.

Thesis. Submitted to London Univ.

Alkyl iodides and their mixtures were irradiated with ^{60}Co gamma rays. Hydrogen iodide and iodine formation was measured as a function of dose for deaerated liquid and solid alkyl iodides and their mixtures. G-values for hydroperoxide formation in aerated alkyl iodides were measured and evidence was found for dialkyl peroxide formation in aerated alkyl iodides. Absorption spectra of the charge transfer complexes, IRI, formed in the pulse radiolysis of alkyl iodides, were measured and molar extinction coefficients and rate constants for the decay of IRI were obtained. The effects of oxygen and iodine on the formation and constant of decay of IRI were studied. Pulse radiolysis studies of alkyl iodides indicated that the decomposition of solute is larger than that expected on the basis of energy directly absorbed by the solute. (ATD)

30437 (BAW-3714-3) GEL-ADDITION PROCESS CHEMICAL STUDIES. Quarterly Progress Report No. 3, January–March 1967. Moncrief, E. C. (comp.) (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). May 1967. Contracts AT(30-1)-3714; 59-3100. 39p. Dep. CFSTI.

Development of the Gel-Addition Process for preparing plutonia-urania mixed oxide fuels has been extended from a study of the interaction of UO_2 gels and Pu solutions to include development of equipment for firing to oxides and methods for examining oxide microstructure. Improving the uptake of Pu on UO_2 gel spheres, decreasing the attrition and losses of gel spheres, and determining the distribution of Pu in contacted gel and fired oxide spheres are discussed. Notable success was achieved in each of these areas. Pu uptake ranging from 20–23% Pu/U + Pu was obtained in both gel and fired oxide spheres that had been double-contacted with Pu(IV) nitrate solutions. Attrition of UO_2 gel spheres contacted with HNO_3 under inert atmosphere was reduced as low as 1%. Alpha autoradiographs of calcined gel-addition spheres showed uniform distribution of Pu within each sphere, although a slight variation was noted between spheres. (auth)

30438 (BMwF-FBK-67-21) STRAHLENCHEMISCHE INITIIERUNG BEI DER BESTIMMUNG DER MITTLEREN LEBENSDAUER DER WACHSENDEN KETTE IN DISPERSEN POLYMERISATIONSSYSTEMEN. (Mean Life Time Measurements of the Growing Chain for Radiation Induced Polymerization in Dispersed Systems). Schneider, Christel; Ley, G. (Cologne Univ. (West Germany)). Mar. 1967. 12p. (In German). Dep.

Intermittent ^{60}Co γ irradiation was used to determine the mean life-time of growing chains in emulsion polymerization. Values of the mean life-time of radicals and of the termination rate constant of eight vinyl monomers and chloroprene are given. For the styrene system the influence of conversion, emulsifier concentration, and temperature were examined. It was concluded that the observed termination reaction must proceed via an exchange of radicals between different monomer-polymer particles, which hitherto have been considered to be completely isolated. (auth)

30439 (BMwF-FBK-67-23) STRAHLENCHEMISCHE DARSTELLUNG VON CHLORALKYLPHOSPHORDICHLORIDEN. (Radiation Chemical Synthesis of Chloro-Alkyl-Phosphor-Dichlorides). Wunder, K. (Technische Universitaet, Berlin (West Germany)). Mar. 1967. 14p. (In German). Dep.

Chloroalkyldichlorophosphines are formed by a Kharasch-type chain reaction when a mixture of phosphorus trichloride and an olefin is irradiated by γ rays. The G-values are inversely proportional to the dose rate and depend also on the temperature, the concentration of the reactants, and the nature of the olefin. Under

optimal conditions the G-values approach 2000 so this method seems to be good for the synthesis of these compounds. At higher temperature the yields of the Kharasch-products decrease, because a new chain reaction that forms products of lower chlorine content becomes significant. (auth)

30440 (COO-1088-27) THE RADIATION CHEMISTRY OF HIGH POLYMERS. Technical Report No. 12, April 1, 1966-April 1, 1967. Dole, Malcolm (Northwestern Univ., Evanston, Ill. Dept. of Chemistry). May 1, 1967. Contract AT(11-1)-1088. 19p. Dep. CFSTI.

Developments are reported for studies on: development of combined uv and ir cell for absorption spectra measurements at liquid nitrogen temperature; ir spectra of irradiated polyethylene at liquid nitrogen temperature; temperature coefficient of crosslinking, double bond formation, and hydrogen gas evolution in irradiated polyethylene; theory of gel crosslink relations and computer solution of the resulting equations; and radiation chemistry of polypropylene oxide. (P.C.H.)

30441 (COO-1580-1) CONTROLLED POLYMERIZATION OF ADSORBED MONOLAYERS. Technical Progress Report. Livingston, H. K. (Wayne State Univ., Detroit, Mich. Dept. of Chemistry). Dec. 15, 1966. Contract AT(11-1)-1580. 15p. Dep. CFSTI.

Research showed that orientation of physically adsorbed molecules can be determined and physically adsorbed layers at near monolayer concentration can be polymerized. The close packing of nitrogen in physical adsorption on a solid surface was compared with that of benzene and furan. The radioinduced polymerization of adsorbed acrylamide and of furan adsorbed on Graphon is described. (M.C.G.)

30442 (EUR-3282,d) NEUBILDUNG MARKIERTER MOLEKUELE BEI DER URANSPALTUNG. (Formation of Labelled Compounds under Neutron Irradiation). Born, J. H. (Technische Hochschule, Munich (West Germany). Institut fuer Radiochemie). 1967. 19p. (In German). Dep.

Experiments involving the neutron irradiation of benzene chromium tricarbonyl are presented. The results show that chromium hexacarbonyl was formed as the preferential reaction product after the (n,γ) process. The dependence of the reaction product yields on the irradiation temperature and on annealing was determined. Discussion of the data thus obtained revealed clearly that not free chromium atoms, but rather chromium atoms containing carbonyl groups, are mainly formed during the primary reaction, thus impeding the formation of dibenzene chromium. An account is given of studies on the chemical reactions that take place after isomeric transitions. A mixture of the isomeric pair $^{80m}Br/^{80}Br$ was produced by the neutron reduction of bromine and mixed with halogen benzolene. Gas-chromatographic analysis in conjunction with activity determinations suggests that it is not only the ^{80}Br atoms from the isomeric transition which cause substitute reactions but that inactive bromine also plays a major part in these reactions, and the necessary energy can apparently only come from the isomeric transitions. (auth)

30443 (IA-1079) A COMPILATION OF SPECIFIC BIMOLECULAR RATE CONSTANTS FOR THE REACTIONS OF HYDRATED ELECTRONS, HYDROGEN ATOMS, AND HYDROXYL RADICALS WITH INORGANIC AND ORGANIC COMPOUNDS IN AQUEOUS SOLUTION. Anbar, M.; Neta, P. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). Feb. 1966. 52p. Dep.

The specific rate constants of reactions of hydrated electrons were determined for over 500 compounds and are presented in tables. Reactions of hydrogen atoms and hydroxyl radicals were also studied and the data tabulated. (M.C.G.)

30444 (TID-23839) GRAFT POLYMERIZATION OF COMONOMERS. Kruse, Robert L. (Columbia Univ., New York. School of Engineering and Applied Science). 1967. 115p. Dep. CFSTI.

Thesis.

The radioinduced grafting of acrylonitrile-styrene to polyethylene was used to test theoretical equations derived for diffusion-controlled grafting of polymer films. The equations were found to be useful for describing the effects of film thickness and radiation intensity in the polyethylene-styrene-acrylonitrile system. The theoretical equations describe the quantitative effects of diffusion on the grafting reaction in terms of the change from volumetric to surface grafting reaction in terms of the change from volumetric to surface grafting, the L_{cv} and L_{cs} values, and the shift of the order of dependence of R_p on R_i. Studies were also made on the copolymer composition of grafted side chains. Mixtures of butadiene-acrylonitrile, styrene-acrylonitrile, styrene-4-vinylpyridine, and styrene-methyl acrylate were grafted to poly(vinyl alcohol) and cellulose, poly(vinyl chloride), polytetrafluoroethylene, and polyethylene by gamma irradiation. From the results it was concluded that graft and nongraft copolymer compositions are in fact identical within the accuracy of infrared measurements. (P.C.H.)

30445 (USNRDL-TR-67-44) RADIOLYSIS OF SEAWATER. Pestaner, J. F. (Naval Radiological Defense Lab., San Francisco, Calif.). Apr. 3, 1967. Contract AT(49-7)-2886. 27p. Dep. CFSTI.

The molecular radiolysis products of seawater were determined in order to evaluate whether these products, and therefore the residual radiation field that produced them, could have an effect on the chemical and physical species of the radionuclide debris produced in an underwater nuclear explosion. The $G(H_2)$ was 0.44 ± 0.01 for aerated seawater and 1.03 ± 0.01 for outgassed seawater. G(peroxide) was 1.03 ± 0.06 for the initial yield in aerated and outgassed seawater. Speculations on the mechanisms to account for these yields are based on the influence of the major components of seawater that are likely to change the known mechanisms for pure water. (auth)

30446 MECHANISM OF ELECTRON IMPACT INDUCED ELIMINATION OF KETENE IN CONJUGATED CYCLOHEXENONES AND CORRELATIONS WITH PHOTOCHEMISTRY. Burlingame, A. L.; Fenselau, Catherine; Richter, W. J.; Dauben, W. G.; Shaffer, G. W.; Vietmeyer, N. D. (Univ. of California, Berkeley). J. Amer. Chem. Soc., 89: 3346-7(June 21, 1967).

Various pathways for the loss of ketene from 2-cyclohexenone derivatives under electron bombardment were examined. It is suggested that ketene is lost through a rearranged bicyclo-[4.1.0]-hexan-2-one system, whose formation requires one or another bond migration from the substituted γ carbon. (J.G.B.)

30447 RADIATION CHEMICAL DECOMPOSITION OF HYDROCARBONS. THE OXIDATION OF METHANE. Luther, Horst; Boenisch, Detlef; Baumgarten, Gerd (Technische Hochschule, Clausthal, Ger.). Brennstoff-Chem., 47: 375-83(1966). (In German).

The oxidation of methane by γ rays from a ^{60}Co source under normal conditions in the presence of Kr as a radiation sensitizer was studied. The type of inert gas added, mixing ratio of the reactants, period of irradiation, pressure variations, temperature variations, wall variations, and additives were examined. Products analyzed were CO, CO_2, CH_3OH, HCOOH, and $HCOOCH_3$. The intermediate oxidation step products all showed a maximum in partial pressure as a function of irradiation time; yields of CH_3OH and HCOOH decreased with increasing temperature. Maximum yields of these products were also obtained at a $Kr : CH_4 : O_2$ ratio of 40 : 7 : 3. Interrelations of the yield of methanol, formic acid, and methyl formate are discussed in connection with mixing ratio experiments. (BBB)

30448 VISCOELASTIC PROPERTIES OF SINGLE-CRYSTAL MATS OF SOME POLYMERS AND POLYMER CRYSTAL OBTAINED BY RADIATION-INDUCED SOLID-STATE POLYMERIZATION. Takayanagi, Motowo; Imada, Kiyohisa; Nagai, Akihiko; Tatsumi, Tetsujiro; Matsuo, Takaaki (Kyushu Univ., Fukuoka, Japan). J. Polym. Sci., Pt. C, No. 16, 867-76(1967).

From International Symposium on Macromolecular Chemistry, Prague, Aug. 30-Sept. 4, 1965. See CONF-650801-(Pt.2).

Measurements of tensile dynamic viscoelasticity were made in the temperature range from -170°C to near the melting temperature at 110 cps on single-crystal mats of linear polyethylene with different lamella thickness and trans-1,4-polybutadiene, and the polymer crystal of polytetraoxane prepared by radioinduced solid-state polymerization of tetraoxane. Under the conditions of measurement, the stress applied was almost perpendicular to the molecular axis for the single-crystal mat and parallel to the molecular axis for the polytetraoxane crystal. The crystalline absorption of the single-crystal mat of linear polyethylene shifted to the high-temperature side and increased its intensity with increasing lamella thickness. The single-crystal mat of trans-1,4-polybutadiene showed comparatively large primary absorption, which was almost eliminated by heat treatment. This phenomenon may be caused by the existence of loose loops in the single-crystal sample. Various absorptions of polyoxymethylene, such as crystalline and low-temperature secondary absorption almost completely vanished for the polytetraoxane crystal, and outstanding constancy of the dynamic modulus was attained close to the melting temperature 190°C. (auth)

30449 PRODUCTION AND ANNEALING OF Br_2 IN THE RADIOLYSIS OF POLYCRYSTALLINE C_2Br_6: AN IN SITU DETERMINATION. Iyer, R. M.; Willard, J. E. (Univ. of Wisconsin, Madison). Contract AT(11-1)-32. J. Chem. Phys., 46: 3501-6 (May 1, 1967). (COO-32-125).

Spectrophotometric analysis of pressed tablets of polycrystalline C_2Br_6 was used to study the growth and decay of Br_2 in the matrix

as a function of γ dose, and of time and temperature of annealing. $G(Br_2)$ is 4 or higher at doses of 10^{18} eV g^{-1} and below but falls rapidly in the range of 10^{18} to 10^{19} eV g^{-1}, reaching values of a few tenths at doses above 10^{20} eV g^{-1}, indicating radiation-catalyzed back reactions. On thermal annealing, part of the Br_2 produced by irradiation is removed rapidly by reactions within the crystal at 76°C, and faster at 100°C, while part is relatively unaffected by the annealing. The rate of production of Br_2 by irradiation is not affected by adsorbed Br_2 incorporated in the crystals prior to pressing the tablets. Reaction intermediates that may be responsible for the observed phenomena are discussed. The exchange of $Br_2(^{82}Br)$ with C_2Br_6 in the tablets and its loss by diffusion were tested. (auth)

30450 THEORY OF GEL–DOSE CURVES FOR POLYMERS UNDERGOING SIMULTANEOUS CROSSLINKING AND SCISSION. Saito, O.; Kang, H. Y.; Dole, M. (Northwestern Univ., Evanston, Ill.). J. Chem. Phys., 46: 3607-16(May 1, 1967). (COO–1088-24).

Computer calculations of the fraction of gel as a function of radiation dose enabled tables to be constructed of the relation between gel fraction and number of crosslinks for various initial weight to number average molecular weight ratios and for a number of different ratios of chain scissions to crosslinks. The theory is based on the Wesslau molecular-weight distribution function and the results are in much better agreement in the case of many polymers than are the theoretical calculations of Inokuti based on a normalized Poisson distribution equation or the theory of Charlesby–Pinner based on a random molecular-weight distribution. It is shown that the initial slope of the $(s + s^{1/2})$-vs-(r_g/r) curve is more helpful in many cases in determining the ratio of scissions to crosslinks than is the intercept at infinite dose. Indications of the breadth of the initial molecular weight distribution can also be obtained from the initial slope. (auth)

30451 ELECTRON SPIN RESONANCE OF X-IRRADIATED VALINES. Shields, Howard; Hamrick, Phillip; DeLaigle, Dean (Wake Forest Coll., Winston-Salem, N. C.). J. Chem. Phys., 46: 3649-52(May 1, 1967). (ORO–2835-9).

X-irradiation of single crystals of dl-valine, d-valine, and l-valine produced free radicals identified as $(CH_3)_2\dot{C}CH(^+NH_3)COO^-$ These single-crystal studies showed that the radical in dl-valine is not $(CH_3)_2\dot{C}CH_2COOH$ as reported earlier [S. Z. Shul'ga and A. I. Telyatmik, Ukrayin. Fiz. 9, 185 (1964)]. Spectra resulting from an equal interaction of the unpaired electron with the protons of the two methyl groups consist of seven main components. Each of these seven components is split into equal triplets by an interaction with the ^{14}N nucleus of the amino group. The origin of the triplet splitting was verified by examining a sample enriched to about 50% with ^{15}N. At some orientations coupling with the β proton can be resolved. The maximum observed β-proton coupling was 4 G. The principal values of the methyl group proton hyperfine coupling constants are (in gauss) 24.4, 23.2, and 22.4. Principal values for the ^{14}N hyperfine coupling constants are (in gauss) 9.0, 7.3, and 6.9. (auth)

30452 ENERGY TRANSFER IN THE RADIOLYTIC ISOMERIZATION OF STILBENE IN FROZEN BENZENE. Fischer, Ernst (Weizmann Inst. of Science, Rehovoth, Israel); Fischer, Gabriella; Stein, Gabriel. Contract AT(30-1)-3242. J. Chem. Phys., 46: 3680-2(May 1, 1967). (NYO–3242-19).

The effects of γ rays from a ^{60}Co source on 5×10^{-5}M solutions of trans-stilbene in benzene were investigated. At this low concentration the isomerization yields G were much lower than G ~ 2.5 obtained in a 0.1M solution. The isomerization rate increased about sevenfold on passing from liquid benzene to solid benzene. In the presence of naphthalene the isomerization rate in liquid solutions was about 12 times higher than in the absence of naphthalene but was lower for solid solutions. (M.C.G.)

30453 γ RADIOLYSIS OF LIQUIDS AT HIGH PRESSURES. II. AQUEOUS SOLUTIONS OF CERIC SULFATE. Hentz, Robert R.; Farhataziz; Milner, David J.; Burton, Milton (Univ. of Notre Dame, Ind.). J. Chem. Phys., 46: 4154-5(May 15, 1967).

The γ radiolysis of 0.8N H_2SO_4 solutions of ceric sulfate was studied over the pressure range from atmospheric to 6.4 kbar. Results of this study, when combined with those for deaerated 0.8N H_2SO_4 solutions of ferrous sulfate, establish that the primary yields of water radiolysis are invariant as pressure varies from atmospheric to 6.4 kbar. (M.C.G.)

30454 DIRECT OBSERVATION OF REGIONS OF HIGH ION AND RADICAL CONCENTRATION IN THE RADIOLYSIS OF WATER AND ETHANOL. Thomas, J. K.; Bensasson, R. V. (Argonne National Lab., Ill.). J. Chem. Phys., 46: 4147-8(May 15, 1967).

The rates of reaction of solvated electrons in water and ethanol were studied. Single 3-nsec pulses of 3-MeV electrons were used, producing in the liquid sample approximately 2 μM solvated electrons per pulse. The results demonstrated the existence of regions of high ion and radical concentration in the radiolysis of liquids, called "spurs." These "spur" reactions occurred slowly over times involving tens of nanoseconds. (M.C.G.)

30455 CHEMISTRY OF IRRADIATION-INDUCED POLYTETRAFLUOROETHYLENE RADICALS. I. REEXAMINATION OF THE EPR SPECTRA. Siegel, Seymour; Hedgpeth, Herbert (Aerospace Corp., El Segundo, Calif.). J. Chem. Phys., 46: 3904-12(May 15, 1967).

The electron paramagnetic resonance (EPR) spectra of radicals formed during the γ-irradiation of polytetrafluoroethylene (PTFE) were examined and assigned. It is shown that both chain radicals (e.g., $RCF_2\dot{C}FCF_2R$) and propagating radicals (e.g., $RCF_2CF_2\cdot$) are formed and stabilized when PTFE is irradiated in vacuum and at room temperature; the yield of the chain radical is 10 times that of the propagating radical. When PTFE is irradiated in air, the peroxide radicals $RCF_2CFOO\cdot CF_2R$ and $RCF_2CF_2OO\cdot$ are stabilized. The difference in yields of the two peroxide radicals is a function of total dosage, with the relative contribution of $RCF_2CF_2OO\cdot$ increasing with increasing dose. Both of the peroxide radicals are converted to the $RCF_2CF_2\cdot$ radical when they are irradiated with ultraviolet light (λ = 280 ± 20 mμ) in vacuum. Some chain radical is produced by the photolysis of its peroxide, but the yield of the propagating radical is 50 times that of the chain radical. The EPR spectrum of the $RCF_2CF_2\cdot$ radical consists of three sets of lines. The central set is a well-resolved triplet with a splitting between adjacent lines of 16 ± 0.5 G. The wing lines are broadened by anisotropic nuclear hyperfine interactions, and the expected triplet structure is not resolved. From the room-temperature spectrum, it is estimated that the isotropic component of the α-fluorine interaction is ~85 G. Also, from the 77°K spectrum, it is estimated that the maximum anisotropic component of the hyperfine interaction tensor is ~140 G. The g value for this radical is 2.0038 ± 0.0001. (auth)

30456 ABS RESINS BY RADIATION-INDUCED GRAFT COPOLYMERIZATION. Tsurugi, Jitsuo (Radiation Center of Osaka Prefecture). Genshiryoku Kogyo, 12: No. 9, 38-42; 79 (Aug. 1966). (In Japanese).

The preparation of several kinds of ABS resin (acrylonitrile-butadiene-styrene copolymers) was attempted by irradiating the emulsions of mixed polymers and monomers in various combinations with ^{60}Co γ rays. The combination most extensively studied was acrylonitrile and styrene monomers emulsified in polybutadiene latex. The velocity of monomer conversion was directly proportional to the dose rate. The effect of the emulsifier used was investigated. The mechanical properties of the resulting ABS polymer were not inferior to those of commercial ABS resins. (NSA of Japan)

30457 RADIATION-INDUCED ADDITION REACTION OF THIOLS TO CHLOROFLUOROETHYLENES. Ueda, Teruo; Inukai, Kan (Government Chemical Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku, 16: No. 2, 42-7(Feb. 1967). (In Japanese).

The addition of thiols to chlorofluoroethylenes was carried out under γ irradiation to produce chlorofluoroethyl alkyl sulfides. Chlorofluoroethyl alkyl sulfoxides and sulfones were prepared by oxidation of the sulfides. The dehydrohalogenation of chlorofluoroethyl alkyl sulfides yielded chlorofluorovinyl alkyl sulfides, whose structure indicated that the thiyl radical attacks the difluoromethylene side of the asymmetrical dichlorodifluoroethylene. Chlorofluorovinyl sulfoxides and sulfones were also synthesized from the sulfides by oxidation with hydrogen peroxide. (NSA of Japan)

30458 STUDIES ON FREE RADICALS PRODUCED BY IRRADIATION. 3. ESR LINE SHAPE DUE TO ANISOTROPIC α-FLUORINE HYPERFINE COUPLING IN THE POLY-CRYSTALLINE STATE. Iwasaki, Machio (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku, 15: 407-13(Dec. 1966). (In Japanese).

The ESR line shape due to an anisotropic α-fluorine coupling was calculated including the nuclear Zeeman interaction. Since it was desirable to see the effect of the nuclear Zeeman term explicitly, the line shape was calculated for the ideal case where the component line width is infinitesimally small. In such a case, it was possible to derive the shape function analytically for an axially symmetric hyperfine tensor, and even for an orthorhombic symmetry the numerical integration in the line shape function was not very difficult. The numerical calculation was executed for the α-fluorine coupling with the tensor elements of 189, −4, and −16 G, and the result was compared with the simpler cases in which the nuclear Zeeman term is neglected. (NSA of Japan)

30459 ESR OF IRRADIATED POLYETHYLENEOXIDE. Aoki, Akira; Sawada, Sigemasa (Industrial Research Inst. of Osaka Prefecture). Osaka Furitsu Kogyo-Shoreikan Hokoku, No. 40, 68-72(1966). (In Japanese).

ESR spectra of polyethyleneoxide (PEO) irradiated with an electron beam from a Van de Graaff accelerator were studied. Irradiations were carried out at 77 or 195°K in vacuum or air. In order to identify the radicals, these experiments were carried out under various experimental conditions. In uniaxially oriented samples, which were prepared from the single crystals or the stretched films of PEO, the doublet spectrum showed remarkable anisotropy with regard to θ, the angle between the applied magnetic field and the oriented direction of samples. On increasing microwave power, the shape of the doublet showed little change. The doublet was attributed to the free radical $(-O-\dot{C}H-C-O-)$. ESR spectra of the samples of PEO irradiated and observed at 77°K were apparently singlet and broad (maximum slope width 47 G). No anisotropy with regard to θ was observed but a change of the maximum slope (47 to 30 G) with increasing microwave power was shown. In the gradual increase of sample temperature from 195 to 273°K, singlets turned into doublets at about 243°K. The singlets seemed to consist of more than two free radicals, $-CH_2-\dot{C}H_2-O\cdot$, $-\dot{C}H-C-O-$, $-O-CH_2-\dot{C}H-O-$, etc. (NSA of Japan)

30460 VAPOR-PHASE GRAFT POLYMERIZATION ON POLYMERS PRE-IRRADIATED IN AIR. EFFECT OF CO-EXISTENT GASES. Oda, Eisuke; Hoshino, Nobuo (Furukawa Electric Co., Ltd., Japan). FAPIG (Tokyo), No. 41, 124(July 1966). (In Japanese).

A study was made on the effect of coexistent gases on the vapor-phase graft polymerization of styrene onto low-density polyethylene pre-irradiated in air. The pre-irradiation was done with ^{60}Co γ rays at the dose rate of 5.5×10^4 R/hr to the total dosage of 2.75 MR. When the coexistent gas was an inert gas such as N_2 or Ar with low solubility in the polymer, the grafting ratio decreased or increased, depending on whether the reaction velocity was diffusion-controlled or reaction-controlled. When the coexistent gas was the vapor of benzene, a good solvent for polystyrene and a good swelling agent for polyethylene at the reaction temperature, the grafting was accelerated at low benzene concentrations (below 15%) but retarded at high benzene concentrations. This retarding effect may be caused by the lowering of styrene concentration due to accumulation of benzene in the polymer, and also by bimolecular termination between the free radical terminals in the swelled polymer matrix. The presence of a trace amount of CCl_4 retarded the reaction; this may be explained by considering the chain transfer. The presence of a small amount of methanol, a poor solvent for both polyethylene and polystyrene, accelerated the reactions; this may be explained by the gel effect produced by the suppression of the mobility of the free radical terminals in the presence of methanol. (NSA of Japan)

30461 RADIOINDUCED COPOLYMERIZATION OF STYRENE AND SULFUR DIOXIDE. Kuri, Zenichiro; Ito, Masayuki (Nagoya Univ., Japan). Kogyo Kagaku Zasshi, 69: 1066-9(May 1966). (In Japanese).

Radioinduced copolymerization of styrene and SO_2 was studied between room temperature and −196°C. The monomer ratio of the polysulfone obtained at room temperature was 2:1 (styrene to sulfur dioxide), and the polymer yield increased with the styrene concentration in starting materials. The monomer ratio at −78°C was about 1:1 and the yield had a maximum at a 1:2 mixture. If a considerable amount of methylene chloride or a small amount of DPPH was added, the yield of polysulfone decreased and polystyrene was formed, which suggests an ionic mechanism. (NSA of Japan)

30462 RELATIONSHIP BETWEEN γ-INDUCED GRAFTING RATES AND THE STRUCTURAL FACTORS OF DIENE POLYMERS. Tsurugi, Jitsuo; Fukumoto, Tsugio (Radiation Center of Osaka Prefecture). Kogyo Kagaku Zasshi, 69: 993-6(May 1966). (In Japanese).

The γ-induced polymerization rates of acrylonitrile in the presence of various types of diene polymers were determined in benzene solutions at room temperature. Approximate proportionality of grafting rates to the root of the radiation dose rates was observed in all the diene polymers used. The grafting rates in the presence of 1,4-polybutadienes were, in general, greater than those in the presence of 1,4-polyisoprenes. Both rates in the presence of cis- and trans-1,4 polyisoprenes were approximately equal. However, the rate in the presence of trans-1,4-polybutadiene was a little higher than that in the presence of the cis isomer, and the grafting rate in the presence of isotactic-1,2-polybutadiene was much smaller than those of the two 1,4-isomers. By using the same diene polymers and N-vinylcarbazole as a monomer, a similar trend was observed. The dependence of grafting rates on structural factors is discussed from the point of view of reactivity of the resulting polymer radicals. (NSA of Japan)

30463 VAPOR-PHASE GRAFT POLYMERIZATION ON POLYMERS PREIRRADIATED IN AIR. PART I. COMPARISON OF VARIOUS METHODS OF GRAFTING. Oda, Eisuke; Hoshino, Nobuo (Furukawa Electric Co., Ltd., Japan). Furukawa Denko Jiho, No. 40, 40-4(Dec. 1965). (In Japanese).

Various methods for graft polymerization with ionizing radiation were compared and problems involved in the methods are discussed on the basis of experimental data. In graft polymerization by pre-irradiation in air, the peroxide contents of polyethylene films irradiated at low dose rates (10^4 to 10^5 R/hr by ^{60}Co γ rays) and at high dose rates (10^5 to 10^8 RAD/sec by electrons from linear accelerator) were estimated from carbonyl absorption in the infrared spectra. The difficulty in the peroxidization of thick films when irradiated at high dose rates showed that peroxidization was controlled by diffusion of O_2 in the films. The apparent activation energy for the decomposition of the peroxide formed in the polyethylene was calculated from the relative rate of grafting, which was a little over 20 kcal/mol. The grafting velocity of polymers pre-irradiated in air was generally smaller in vapor-phase grafting than in the liquid-immersion grafting, but when the grafting was done in saturated monomer vapor, the velocity was the same as in liquid-immersion grafting. In the vapor-phase grafting of styrene onto polyethylene pre-irradiated in air, the velocity of grafting was proportional to the third power of the pressure of the monomer vapor when the pressure was fairly low so that the process was diffusion-controlled. (NSA of Japan)

30464 IONIZATION MECHANISM OF THE ACTIVATION OF DIFFUSION BY RADIATION. Starodubtsev, S. V.; Kiv, A. E.; Rozentsvit, G. L. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk SSSR, 172: 907-8(1967). (In Russian).

An investigation was made of the effect of the stationary concentration of ionized atoms generated in the valence crystal by a radiation beam on diffusion processes. The height of the potential barrier, which depends on the forces of atomic interaction, determines the probability of penetration in the diffusion process. In a valence crystal, the height of the potential barrier can be lowered by the attenuation of exchange couplings during multiple ionization of the atomic cores, which causes the polarization of the electron clouds. As a result of the ionization of the inner electron shells, the atoms in the nodes can be displaced under certain conditions. The evaluated change in energy of the exchange coupling due to a single ionization of the atomic core is 0.4 to 0.5 eV; the change due to a double ionization is ~1 eV. When the diffusing, imbedded atom is located near the multiply ionized atom, the potential barrier appears to be lower and the probability of penetration increases. The increase in penetration probability can be expressed as $\gamma = NdNi/N_2 \exp(\Delta E/KT)$. The evaluation of γ when $n_d \sim 10^{17}$, $n_i \sim 10^{15}$, $N \sim 10^{22}$ shows that the probability of barrier penetration of the radiation-stimulated diffusion can increase by several orders in comparison with nonactivated diffusion at the same temperature. (ATD)

30465 EFFECT OF X-RAY IRRADIATION ON INTERDIFFUSION IN ALKALI METAL HALIDE SINGLE CRYSTALS. Geguzin, Ya. E.; Bolko, Yu. I. (Kharkov State Univ.). Dokl. Akad. Nauk SSSR, 172: 820-2(1967). (In Russian).

An experimental investigation was made of the interdiffusion in alkali halide single crystals under conditions of diffusion annealing at constant irradiation. The three-layered A−B−A specimens were KCl−KBr and NaCl−NaBr systems. The thickness of crystal plate A was selected in such a way that the attenuation of the penetrated beam would be 50 to 70%. The thickness of A was 150 to 200 μ; that of B, 2 mm. The diffusion in the A → B contact occurred under the effect of x irradiation, while in the B → A contact the diffusion occurred under usual conditions because of the considerable thickness of B, which absorbed the radiation. The other conditions (temperature, annealing time) in A → B and B → A contacts were identical. In a KCl−KBr system at 560°, the effective diffusion coefficient in the irradiated specimens (D_R), determined according to Motano, appeared to be lower than in nonirradiated specimens (D_o) by almost one order. With an increase in temperature, the difference in diffusion coefficients D_R and D_o diminishes and at temperatures of 620 and 680° the diffusion coefficients were identical in irradiated and nonirradiated diffusion zones. The difference in effective diffusion coefficients is associated with the difference in the total volume of the diffusion pores observed in KBr crystal. The irradiation causing a decrease of effective diffusion coefficient facilitates the growth of the total volume of pores. A qualitative similar effect of x irradiation upon the effective diffusion coefficient was also observed in NaCl−NaBr system. A definite contribution in decreasing the effective coefficient of interdiffusion can be made by the partial attenuation of the electrodiffusion field caused by conduction electrons. The field facilitates the displacement of the most slowly diffusing ion (in the KCl−KBr system, the

Cl^- ion). The decrease in the mobility of the Cl^- ion should lead to a decrease of the effective diffusion coefficient. (ATD)

30466 RADIATION EFFECTS IN CHEMICAL AND SUPERMOLECULAR STRUCTURE OF CELLULOSE. Polcin, Ian (Vyskumny Ustav Papieru a Celulozy, Bratislava). Jad. Energ., 13: 145-9(Apr. 1967). (In Czech).

Gamma irradiation of cellulose, starting with a dose of 10^6 RAD induced a significant rupture of macromolecules with a simultaneous increase in the content of aldehyde, carboxyl, and peroxidized groups. X-ray measurements, measurements of iodine accessibility, infrared spectrometry, and electron microscopy indicated that in spite of the disintegration of chemical bonds, the physical bonds in the highly ordered regions are sufficiently strong to retain hypermolecular systems. A certain structural weakening was observed in less-ordered transitional regions with weak physical bonds. After altering the natural cellulose lattice, the radiation induced a certain weakening of the structure even in highly ordered regions in which the transformations resulted in swelling and weakening of the bonds and, thus of the general linking system of the hypermolecular cellulose structure. (tr-auth)

30467 PROTON RADIOLYSIS OF ALKALI METAL NITRATES. Eremin, L. P.; Lykhin, V. M.; Oblivantsev, A. N.; Boldyrev, V. V. (Tomsk Polytechnic Inst., USSR). Zh. Fiz. Khim., 41: 1180-2 (May 1967). (In Russian).

Radiochemical decomposition of alkali metal nitrates by protons was studied at various temperatures. With the rise of proton-irradiation temperature the yield of alkali metal nitrates increased. The dependence of initial radiochemical yield on the free volume of crystal elementary cells observed during γ-irradiation was also observed during proton radiolysis of alkali metal nitrates. (R.V.J.)

30468 RADIOLYSIS OF PHENYLALANINE AQUEOUS SOLUTIONS. Brodskaya, G. A.; Sharpatyi, V. A. (Inst. of Nuclear Physics, Tashkent). Zh. Fiz. Khim., 41: 1108-13(May 1967). (In Russian).

Effects of ionizing radiation on phenylalanine solutions were studied using 0.01 M solutions of phenylalanine (pH 1 to 14) saturated with N_2 or O_2 and irradiated at 37°C by a cobalt source with 400 RAD/sec dose. Changes in pH of the irradiated phenylalanine solution affected the qualitative and quantitative composition of products of radiolysis. The radiolytic transformation of phenylalanine in acid or alkaline media was related to the phenylalanine side chain reaction with OH and OH_2 (in presence of O_2). In neutral media the oxidation was confined mainly to the aromatic chain. The general phenylalanine radiolysis scheme is included. (R.V.J.)

30469 EFFECT OF ACID ON THE RADIOLYSIS OF ETHANOL. Ackerman, L. G. J.; Basson, R. A. (Atomic Energy Board, Pretoria). Chem. Commun., No. 12, 586-7(June 21, 1967).

Radiolytic yields of H_2, CH_3, CHO, and butanediol were determined from ethanol as a function of acid concentration. Results did not agree with literature predictions for the mechanisms being the result of scavenging of solvated electrons in the spurs. Other workers also reported results incompatible with this mechanism. A revised mechanism is suggested. It is considered that the influence of added acid is to scavenge the reaction $Et\,O(CH_3)\cdot CH\cdot OH) + e^-_{solv.} \rightarrow EtO^-$, and by so doing produce an additional yield of hydrogen atoms through the reaction $e^- + EtOH_2^+ \rightarrow EtOH + H$. For each solvated electron scavenged two additional hydroxyethyl radicals are produced. It was shown that 1-dydroxyethyl radicals undergo both disproportionation and dimerisation, and that the two processes are approximately of equal importance. The mechanism predicts that $\Delta G_{glycol} = \Delta G_{CH_4\cdot CHO} = 0.5\,\Delta G_{H_2}$. (UK)

30470 RADIATION CHEMISTRY OF AQUEOUS, OXYGEN-CONTAINING SOLUTIONS OF 5-BROMOURACIL. I. IDENTIFICATION OF RADIOLYTIC PRODUCTS. Gilbert, E.; Volkert, O.; Schulte-Frohlinde, D. (Kernforschungszentrum, Karlsruhe, Ger.). Z. Naturforsch., 22b: 477-80(May 1967). (In German).

After ^{60}Co γ-irradiation of aqueous, oxygen-containing 5-bromouracil solutions five compounds were isolated and identified: diisobarbituric acid, urea, isobarbituric acid, alloxan, and isodialuric acid. (tr-auth)

30471 RADIATION CHEMISTRY OF AQUEOUS, OXYGEN-CONTAINING SOLUTIONS OF 5-BROMOURACIL. II. REACTION OF OH RADICALS WITH BROMOURACIL. Volkert, O.; Bors, W.; Schulte-Frohlinde, D. (Kernforschungszentrum, Karlsruhe, Ger.). Z. Naturforsch., 22b: 480-5(May 1967). (In German).

In the γ-radiolysis of 5-bromouracil in aqueous oxygen-containing solutions, bromide ions, protons, hydrogen peroxide, hydrogen, diisobarbituric acid, isodialuric acid, alloxan, isobarbituric acid, urea, and an unstable peroxide are formed. The G-values of these products were determined in relation to dose, the 5-bromouracil concentration, the pH value, and the O_2 concentration in the solution. On the basis of these results, a mechanism for the decomposition of 5-bromouracil and for the formation of products at pH 1 and high O_2 concentrations is postulated. Under these conditions 5-bromouracil was attacked only by OH radicals. The primary steps consist of the addition of OH radicals to the C=C double bonds of the bromouracil with about the same probability in the 4 and 5 positions. The resulting reactions with O_2 lead to peroxyradicals, which through reactions with one another, with HO_2 radicals, and by ring-opening reactions yield the end products. (tr-auth)

30472 γ-RADIATION-CHEMISTRY REACTIONS OF PHOSPHORUS TRICHLORIDE WITH OLEFINS. Renz, M.; Wunder, K.; Drawe, H. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Z. Naturforsch., 22b: 486-90(May 1967). (In German).

α-chloro alkyl phosphorus dichlorides were synthesized by γ-irradiating mixtures of various olefins with phosphorus trichloride. The G-values were of the order of several hundreds. The effects of the structure of the olefin on the yields at various temperatures are described. A polymer that contains small amounts of phosphorus was formed in mixtures of styrene and PCl_3. Phosphorus trichloride decreased the molecular weight as well as the rate of polymerization of styrene. The decrease in molecular weight can be described by a telomerization mechanism; the transfer constant at room temperature was equal to 0.24. However, the phosphorus content of the polymer was higher than expected from this simple mechanism. The polymerization of α-methylstyrene was accelerated by phosphorus trichloride. (auth)

30473 RADIOLYSIS OF LIQUID HEXAFLUOROETHANE. Sokolowska, A.; Kevan, Larry (Univ. of Kansas, Lawrence). J. Phys. Chem., 71: 2220-2(June 1967). (COO-1528-9).

The γ radiolysis of liquid C_2F_6 at −78° was studied. The 100-eV product yields (G) are CF_4 (1.72), C_3F_8 (0.87), and $n\text{-}C_4F_{10}$ (0.45). With O_2 added as a radical scavenger, the yields are 0.97, 0.0, and 0.0, respectively. From these results $G(CF_3) = G(C_2F_5) = 2.5$. The CF_3/C_2F_5 ratio differs from that found by EPR by which only CF_3 was observed. (auth)

30474 ULTRAVIOLET PHOTOLYSIS OF X-IRRADIATED METHANOL AT 77°K. Milliken, Stephen B.; Johnsen, Russell H. (Florida State Univ., Tallahassee). Contract AT(40-1)-2001. J. Phys. Chem., 71: 2116-23(June 1967). (ORO-2001-3).

X-irradiated methanol was photolyzed at 77°K in the EPR cavity and in bulk samples with selected wavelengths. Wavelengths shorter than 3100 Å led to a continuing production of ·CHO and a steady-state concentration of $\cdot CH_3$ in the matrix; hence the production of CH_4 and CO from the thawed material was proportional to the duration of photolysis time. Wavelengths between 3300 and 4000 Å yielded an amount of ·CHO trapped in the matrix equal to the original concentration of spins produced by x-irradiation. A study of the hydrogen and methane yields was made in both the glassy and the polycrystalline solids. (auth)

30475 ELECTRON SPIN RESONANCE OF X-RAY IRRADIATED POLYCRYSTALLINE AND SINGLE-CRYSTAL SODIUM HEXAFLUOROANTIMONATE. Herring, F. G.; Hwang, J. H.; Lin, W. C. (Univ. of British Columbia, Vancouver). J. Phys. Chem., 71: 2086-90(June 1967).

The ESR spectra of x-irradiated polycrystalline and single-crystal $NaSbF_6$ were studied. The hyperfine structure was found to be due to ^{121}Sb with $I = 5/2$ and ^{123}Sb with $I = 7/2$. The coupling tensor A for ^{121}Sb was found to be axially symmetric with $A_{||} = 74.6$ gauss and $A_\perp = 60.8$ gauss and the g tensor was also found to be axially symmetric with $g_{||} = 2.018$ and $g_\perp = 2.011$. The ratio of the coupling-tensor components of ^{121}Sb to that of ^{123}Sb was found to agree with the ratio calculated from the accepted values of the nuclear magnetic moments. No hyperfine splittings due to the fluorine atoms were observed. The species was suggested to be either SbF_6^- or SbF_8^{3-}. (auth)

30476 ENERGY TRANSFER IN THE LIQUID-PHASE RADIOLYSIS OF BINARY ALKANE SYSTEMS: CYCLOPENTANE–2,2,4-TRIMETHYLPENTANE, n-HEXANE–2,2,4-TRIMETHYLPENTANE, AND n-HEXANE–CYCLOPENTANE. Kudo, T.; Shida, S. (Tokyo Inst. of Tech.). J. Phys. Chem., 71: 1971-81 (June 1967).

The products from cyclopentane–2,2,4-trimethylpentane binary mixtures were analyzed after irradiation at room temperature. In the mixtures, the yield of hydrogen was reduced from that expected according to the law of averages. On the other hand, the yields of

methane, isobutane, and isobutene were enhanced. These results are all consistent with an energy-transfer mechanism, the transfer occurring from cyclopentane to 2,2,4-trimethylpentane. However, the enhancement of the yields of two C_4 products, compared to the enhancement of the methane yield, was about twice as great as would be expected based on the ratio $G(C_4):G(CH_4)$ for pure 2,2,4-trimethylpentane. Consequently, it was concluded that the compendium of states of precursors for the C_4 products appears to differ depending upon whether they are produced originally or after energy transfer. From runs using methyl methacrylate as a scavenging additive, the "scavenged fractions" for the C_4 products in the mixtures which were found varied appreciably from those in pure 2,2,4-trimethylpentane. This means that, in addition to the spectrum of decomposition paths arising from the pure materials, there is superimposed another pattern of carbon–carbon bond rupture arising from the excited and/or ionized state formed on energy transfer. Similar results were obtained for the n-hexane–2,2,4-trimethylpentane system. However, for the cyclopentane–n-hexane system, although the ionization potentials of the components apparently differ, the results obtained appear to imply ideal behavior of ionic or excited molecular species produced radiolytically in the system and the following mechanism was suggested to occur, with forward and reverse rates balanced in equilibrium: $c\text{-}C_5H_{10}^{+} + n\text{-}C_6H_{14} \rightleftharpoons c\text{-}C_5H_{10} + n\text{-}C_6H_{14}^{+}$; $c\text{-}C_5H_{10}^{*} + n\text{-}C_6H_{14} \rightleftharpoons c\text{-}C_5H_{10} + n\text{-}C_6H_{14}^{*}$. (auth)

30477 ELECTRON-HOLE TRAPPING IN X-IRRADIATED CALCIUM CARBONATE AND SODIUM NITRATE. Cunningham, Joseph (National Physical Lab., Teddington, Eng.). J. Phys. Chem., 71: 1967-70(June 1967).

High efficiencies of formation of NO_3^{2-} in $NaNO_3$ crystals and of CO_3^{-} and CO_3^{2-} in $CaCO_3$ crystals by x-irradiation at 77°K are compatible with their production by secondary electrons of initial energies <100 eV. The ESR signal intensities from these radicals varied with thermal annealing or optical bleaching in the manner expected for trapped electrons and holes coexisting after irradiation. Neither the narrow and invariant line widths observed from radicals trapped in $CaCO_3$ nor the absence of satellite lines in these spectra would be expected if the spatial distribution of trapped electrons and holes was similar to that reported for energy-loss events involving secondary electrons. (auth)

30478 RADIATION-INDUCED OXIDATION OF LIQUID METHANOL. Habersbergerova, A.; Janovsky, I.; Teply, J. (Inst. of Nuclear Research, Prague). Collect. Czech. Chem. Commun., 32: 1860-70(May 1967).

Determination of the dependence of the yields of hydrogen peroxide, hydroxymethyl hydroperoxide, and formic acid on oxygen concentration proved that oxygen is an efficient scavenger of CH_2OH radicals. Comparison of the experimentally found oxygen consumption with that calculated from the yields of oxidation products showed that the main products of the radioinduced oxidation of methanol were the previously mentioned products and formaldehyde. A reaction scheme is suggested, illustrating the dependence of the yields of hydroxymethyl hydroperoxide, hydrogen peroxide, formaldehyde, and oxygen consumption on the reciprocal square root of the dose rate and the independence of hydrogen yield of dose rate. At higher doses carbon dioxide was formed and formic acid was decomposed as a result of secondary reactions. (auth)

30479 EFFECTS OF DOSE INTENSITY ON THE KINETICS OF RADIOLYSIS OF CYCLOHEXANE. CYCLOHEXANE AS A CHEMICAL DOSIMETRIC SYSTEM. Makarov, V. I.; Polak, L. S. (Inst. of Petrochemical Synthesis, Moscow). Neftekhimiya, 7: 219-23(Mar.-Apr. 1967). (In Russian).

Kinetics of cyclohexane radiolysis product yields (hydrogen, bicyclohexyl, cyclohexene, and fragment products of C_1 to C_4) were studied at various doses from 1.4×10^{16} to 3.6×10^{18} eV/ml sec (in some cases up to 2.8×10^{17} eV/ml sec) and at γ- and electron-irradiation doses from 1×10^{19} to 15×10^{19} eV/ml. The basic radiochemical yields of cyclohexane products resulting from the broken C–H bonds did not prove to be a linear function of the dose. The rate of the yield of products was not affected by the radiation dose range examined. (R.V.J.)

30480 IRRADIATED POLYMER COMPOSITIONS. Ward, Robert Arthur (to General Electric Co.). British Patent 1,071,032. June 7, 1967. Priority date Sept. 20, 1963, United States.

A method is described for preparing a filled copolymer composition in which a copolymer of ethylene and a vinyl ester or an acrylate monomer or a mixture of such copolymers is mixed with from 50 to 400 wt % of a filler and is irradiated with electrons having an average energy of from 5×10^{6} to 2×10^{7} eV to a dosage of from 2 to 100 MR. The proportion of vinyl ester and/or acrylate monomer to ethylene used is such as to produce a partially crystallized thermoplastic. (B.L.M.)

30481 METHOD FOR THE PRODUCTION OF SHEETS OR FILMS OF FOAMED POLYETHYLENE. Asaoka, Masao (to Hitachi Chem. Ind. Co.). Japanese Patent 1966-6278. Apr. 4, 1966. Filed Mar. 22, 1963.

A method for the production of sheets or films of foamed polyethylene includes blending polyethylene with a foaming agent having a decomposition temperature higher than the melting point of the polyethylene, fabricating the mixture into sheets or films, crosslinking the polyethylene by irradiating the sheets or films with ionizing radiation, and thermally decompositing the foaming agent contained in the sheets or films. The over-all procedure can be continuous, and gives fairly thin sheets or films very readily. (NSA of Japan)

Radiochemistry

Refer also to abstracts 30496 and 31777.

30482 (NRL-MEMO-1764) STANDARDIZATION OF β COUNTING PROCEDURES USED AT NRL IN THE RADIOCHEMICAL ANALYSIS OF AIR FILTER SAMPLES. Saunders, A. W. Jr.; Patterson, R. L. Jr.; Lockhart, L. B. Jr. (Naval Research Lab., Washington, D. C.). May 1967. 32p.

The calibration of β counting systems used for the quantitative determination of radionuclides in air filter collections is described. Solid calibration standards are prepared from a variety of standardized sources of radioisotopes of different β energies by mounting in a reproducible geometry 50.0- and 25.0-mg quantities of carrier material containing known amounts of radioactivity. A calibration curve of counting efficiency vs β_{max} energy is constructed for each counting system, from which the counting efficiency of a wide variety of radionuclides having nonforbidden spectra can be derived. (auth)

30483 (AEC-tr-6863) FIRST ANNUAL REPORT [ON] RESEARCH CONTRACT (009-65-2 WAS D) BETWEEN THE EUROPEAN ATOMIC ENERGY COMMUNITY AND LEYBOLD HIGH-VACUUM WORKS, GmbH [ON CONCENTRATION OF AQUEOUS SOLUTIONS OF RADIOACTIVE SALTS]. (Leybold-Hochvakuum-Anlagen B.m.b.H., Cologne (West Germany)). Translated from German report. 36p. Dep. CFSTI. JCL $3.60 fs, $1.28 mf.

The design of an experimental installation that concentrates aqueous solutions of radioactive salts to a practically dry final product is described. The process is a combination of low-pressure evaporation and freeze-drying; the use of an ion exchanger is also considered. The conditions are described under which an energy coupling may be carried out. It is shown how the experimental setup complies with the structural and process-engineering requirements of large plants. A separate section is devoted to the measuring technique, which yields adequate results at low cost. The fundamental experiments aiming at the startup and coordination of the experiments are briefly described. (auth)

30484 DESTRUCTION OF MOLECULES BY NUCLEAR TRANSFORMATIONS. Wexler, S. (Argonne National Lab., Ill.). Science, 156: 901-7(May 19, 1967).

Some of the phenomena resulting from nuclear transformations occurring in polyatomic molecules are described. The primary molecular effects discussed are the properties of the product species at the moment of formation, before these properties are altered by collisions of the products with neighboring molecules. The observable properties are the chemical nature, charge states, and kinetic energies of the various fragments formed in the breakup of the molecule. From these measured quantities the mechanisms of molecular disruption induced by nuclear transition can be deduced. Two requirements that must be fulfilled in order to study the decomposition of molecules by nuclear decay are low pressures of radioactive gaseous molecules to ensure that measurements are made on only the primary products and efficient detection and identification of the new species. The molecular disruption observed in a mass spectrometer after negative beta decay, isomeric transition, and orbital electron capture is discussed. The molecular decomposition by radiative neutron capture is also discussed. The characteristics of the molecular disruption depend strongly on the type of nuclear transformation that occurs. Negative beta decay generally causes only mild perturbation of the molecule whereas violent molecular consequences follow the nuclear processes of isomeric transition, orbital electron capture, and radiative neutron capture. (D.H.M.)

30485 PREPARATION AND NEUTRON COUNTING OF $^{238}PuO_2$ DEPLETED IN ^{18}O. Rutherford, W. M.; Huffman, G. N.; Coffey, D. L. (Mound Lab., Miamisburg, Ohio). Contract AT-33-1-Gen-53. Nucl. Appl., 3: 366-71(June 1967).

Plutonium-238 dioxide is a potentially useful source of energy for biological purposes such as the cardiac pacemaker. Experiments showed that neutron contribution to the undesirable external radiation from $^{238}PuO_2$ can be minimized by preparing the compound from oxygen depleted in ^{18}O. Depleted oxygen for these experiments was prepared in a thermal diffusion column in a two-step operation. The ^{18}O content was depleted from the natural abundance of 0.204 to 0.0016 ± 0.0005%. A yield of 30 n/(sec 10^6) alpha particles was found for the (α,n) reaction on ^{18}O. (auth)

30486 INVESTIGATIONS ON THE SZILARD–CHALMERS EFFECT AT REACTOR CONDITIONS. Toerkoe, Janos. Energ. Atomtech., 20: 200-3(Apr. 1967). (In Hungarian).

After a theoretical discussion of the Szilárd-Chalmers effect the possibility of making use of this phenomenon in the production of radioisotopes is considered. Using various compounds of chromium as target, dependence of yield and specific activity of the ^{51}Cr formed on the time of activation and temperature of target was examined. Taking into consideration the conditions in the reactor (neutron flux, gamma radiation and temperature in the irradiating channel, etc.) a method was worked out for production of ^{51}Cr in a quality required for diagnostic use. (auth)

30487 INTRAMOLECULAR MIGRATION OF TRITIUM AND DEUTERIUM DURING NONENZYMATIC AROMATIC HYDROXYLATION. Jerina, D.; Daly, J.; Landis, W.; Witkop, B.; Udenfriend, S. (National Institutes of Health, Bethesda, Md.). J. Amer. Chem. Soc., 89: 3347-9(June 21, 1967).

The application of a recently reported intramolecular shift to nonenzymatic substitution reactions was studied. Because cationoid intermediates might be expected to facilitate such migrations, a variety of typical electrophilic aromatic substitution reactions involving selectively deuterated and tritiated compounds were examined. Of the six systems examined, only hydroxylation of [p-^{3}H]- or [p-^{2}H]acetanilide by trifluoroperacetic acid led to significant migration rather than complete displacement of the para substituent. (J.G.B.)

30488 CHEMICAL STATE OF ^{32}P ATOMS RESULTING FROM THE NUCLEAR REACTION $^{32}S(n,p)^{32}P$ IN ELEMENTARY SULFUR. IV. INFLUENCE OF OXYGEN. Bebesel, P. I.; Turcanu, C. N. (Inst. for Atomic Physics, Bucharest). Rev. Roum. Chim., 12: 441-3(Apr. 1967). (In French).

The influence of O_2 on the chemically stabilized form of ^{32}P atoms in targets of irradiated S was studied. In working with deaerated targets, the results showed the stabilization of the ^{32}P atoms in the elementary form, capable of reacting with PCl_5 to form PCl_3. The study showed the influence of O_2 during the irradiation of elementary S with neutrons. (tr-auth)

30489 CHEMICAL STATE OF ^{32}P ATOMS RESULTING FROM THE NUCLEAR REACTION $^{32}S(n,p)^{32}P$ IN ELEMENTARY SULFUR. III. THE CONCENTRATION OF RADIOPHOSPHORUS IN RED PHOSPHORUS. Bebesel, P. I.; Turcanu, C. N. (Inst. for Atomic Physics, Bucharest). Rev. Roum. Chim., 12: 437-40 (Apr. 1967). (In French).

The concentration in red P of radiophosphorus resulting from the nuclear reaction $^{32}S(n,p)^{32}P$ in various solvents was studied. The chemically stable form of radiophosphorus after its extraction from red P under various conditions of extraction was followed. It was established that the radiophosphorus retained in the red P is the oxidized form. (tr-auth)

Separation Processes

Refer also to abstracts 30347, 30372, 30374, 30392, and 30658.

30490 (AMRA-TR-67-10) SEPARATION OF VANADIUM, ZIRCONIUM, TITANIUM, MOLYBDENUM, TUNGSTEN, AND COLUMBIUM BY ELUTION DEVELOPMENT ION EXCHANGE CHROMATOGRAPHY. Ferraro, Thomas A. (Army Materials Research Agency, Watertown Arsenal, Mass.). Apr. 1967. 27p.

The elution behavior of V, Zr, Ti, Mo, W, and Nb was studied at various hydrofluoric acid concentrations employing a strong base anion exchange resin. The results were used to establish appropriate separation schemes. Coupled columns were employed for the separation of the complete group. Simple columns were used for less complicated mixtures. V, Zr, Ti, and Mo were eluted with appropriate hydrofluoric acid solutions. In this way, interference from large amounts of Nb was avoided. An interval equation defining the desired volume interval between successively eluting solutes is offered for calculating the column length required for a particular separation. This equation is especially useful for determining the extent to which a column must be lengthened when overlapping occurs due to high column loading. (auth)

30491 (BNWL-288) RECOVERY OF CESIUM FROM PUREX ALKALINE WASTE WITH A SYNTHETIC ZEOLITE. Bray, L. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1967. Contract AT(45-1)-1830. 16p. Dep. CFSTI.

The recovery of cesium from Purex process alkaline wastes using an inorganic exchange resin (DECALSO) was studied. The results of laboratory studies using synthetic wastes and hot-cell studies using full level wastes are described. Fission product wastes are concentrated, treated with excess caustic, and stored in underground mild steel tanks. Most of the fission products precipitate and drop to the bottom of the tanks leaving Cs and Na in solution. Recovery of ^{137}Cs is made possible by passing the alkaline supernate directly through a bed of aluminosilicate gel ion exchange material (DECALSO). The cesium is then shipped to Oak Ridge National Laboratory for elution, further purification, and encapsulation. Approximately 3 MCi of ^{137}Cs were shipped to ORNL during the last seven years. Results of an investigation of the loading characteristics of DECALSO considering the cesium retained as a function of sodium to cesium mole ratio, pH, temperature, flow rate of the influent solution, and resin pretreatment are given. Four Purex waste tanks were sampled, and the composition of each alkaline supernate was determined. The composition varied in sodium to cesium mole ratio, pH, and aluminum concentration. Aluminum salts dropped out of solution and plugged the DECALSO resin bed under certain pH, aluminum concentration, and temperature conditions. However, a 5/1 feed to water dilution effectively prevented subsequent precipitation. (D.H.M.)

30492 (CEA-R-3206) ETUDE DES FACTEURS PHYSICO-CHIMIQUES INTERVENANT DANS L'EXTRACTION DE L'URANIUM ET DU PLUTONIUM PAR LE PHOSPHATE DE TRIBUTYLE EN MILIEU NITRIQUE. (Study of the Physico-Chemical Agents Influencing Uranium and Plutonium Extraction by Tributyl Phosphate in Nitric Media). Tarnero, Maurice (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Mar. 1967. 84p. (In French). Dep.

The variables reviewed are tributyl phosphate concentration, nitric acid concentration, influence of inextractable nitrates, simultaneous presence of uranium and plutonium, presence of some different ions, temperature, nature of the diluent, addition of a second active solvent (synergic or antagonistic effect), and tributyl phosphate and diluent degradation. (auth)

30493 (CONF-660904-Vol.1 and 2, pp 741-61) REMOVAL OF PLUTONIUM HEXAFLUORIDE FROM CELL EXHAUST AIR BY HYDROLYSIS AND FILTRATION. Kessie, Robert W. (Argonne National Lab., Ill.).

The fluoride volatility process for recovery of fissionable Pu from spent reactor fuel as the volatile PuF_6 requires a demonstrated ability to contain the highly toxic Pu. The experimental studies indicate that at low concentrations of PuF_6 and moisture, the hydrolysis reaction rate is directly proportional to both the partial pressure of the PuF_6 and moisture and to the area of the solid surfaces available for reaction. Adsorbed PuF_6 and HF reduce the reaction rate at partial pressures greater than 0.001 mm Hg. At high concentrations of PuF_6 and moisture, the reaction proceeds rapidly in the gas phase to produce a finely dispersed product PuO_2F_2. Most of the particles are smaller than 0.1 micron. With air containing excess moisture, the fraction of released Pu penetrating two high-efficiency filters in series amounts to between 10^{-9} and 10^{-6} at a filter-media velocity of 1.0 cm/sec. Filter efficiency is increased by the agglomeration of particles before filtration and by loading effects of the collected particles on the filters. When an excess of moisture is available, agglomeration effects tend to limit the maximum discharge rate of Pu, and loading effects tend to limit the maximum total quantity of Pu that can be discharged from a single filter. (auth)

30494 (CONF-660904-Vol.1 and 2, pp 824-46) MASS TRANSFER OF ^{85}Kr IN CHARCOAL ADSORPTION BEDS. Underhill, Dwight (Harvard School of Public Health, Boston, Mass.).

A fundamental factor in the design of charcoal adsorption beds for fission gases is the number of mass transfer units of the bed—the greater the number of transfer units the more efficient the bed. Using ^{85}Kr tracer in an air carrier, the number of mass transfer units in charcoal beds cooled with dry ice was determined over a wide range of flow velocities and charcoal particle diameters for both adsorption and desorption. The mechanisms of mass transfer as a function of reduced velocity were identified as gas phase diffusion, eddy diffusion and phase inequilibrium. The studies also confirmed the applicability of the Van Deemter equation. (auth)

30495 (DOCKET-50-268) DESIGN AND ANALYSIS [OF THE] MIDWEST FUEL RECOVERY PLANT. (General Electric

Co., Santa Clara, Calif. Nuclear Energy Div.). [nd]. 348p. Dep. CFSTI.

A facility capable of processing 300t/yr of irradiated uranium in the form of compacted UO_2 clad in stainless steel or zirconium alloys to recover uranium, plutonium, and neptunium is described. It will use the Aquafluor process, which includes mechanical disassembly, chemical leaching, solvent extraction, ion exchange, and fluid-bed fluorination. Information and technical data on plant design and analyses of the operational effects on the environs are presented. The preliminary operating plan is given. (M.C.G.)

30496 (EUR-3273.e) PROCESS CELL AND EQUIPMENT FOR TRANSPLUTONIUM ISOLATION AT KARLSRUHE. Mueller, W. (European Atomic Energy Community, Karlsruhe (West Germany). Transuranium Inst.). Nov. 11, 1966. 22p. (CONF-661123-1). Dep.

From International Transplutonium Elements Symposium, Oak Ridge, Tenn.

At the European Transuranium Institute shielded cells were prepared for the processing of transplutonium targets. The equipment designed for this processing is described. (auth)

30497 (EUR-3475.f) RECUPERATION DU ^{90}Sr PAR EXTRACTION LIQUIDE–LIQUIDE A PARTIR DES SOLUTIONS CONCENTREES DE PRODUITS DE FISSION, 1960–1965. (Recovering ^{90}Sr by Liquid–Liquid Extraction From Concentrated Fission-Product Solutions, 1960–1965). Galaud, G.; Lefevre, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Serrini, G. (European Atomic Energy Community). May 1967. 99p. (In French). Dep.

Known processes for recovering Sr-90 by extraction with bis (2-ethylhexyl)phosphoric acid. Owing to the determination of large amounts of magnesium in the fission-products solution, the process had to be completely replanned. A new, original scheme is described, its key operation being a magnesium pre-treatment. The rare earths are first extracted at pH 2, which is virtually unaffected by the magnesium. The overall fission-product decontamination factor as regards strontium was substantially lowered (DF 10-20) and a further stage for purifying strontium with respect to magnesium was necessary. (auth)

30498 (EURAEC-1832) REPROCESSING OF IRRADIATED FUELS. Quarterly Report No. 26, July 1–September 30, 1966. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Contracts 006-65-7RCIB(RD); 016-65-1RAP-B. 95p. (EUR-3355). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Research relating to the processing of dioxide fuel with chlorine trifluoride led to the elaboration of a basic flow sheet, which is being evaluated through experiments and calculations. Study of the formation of plutonium hexafluoride showed that at 400°C the volatilization rate did not increase with chlorine trifluoride concentration. Adding chlorine monofluoride to the trifluoride had a damping effect on plutonium volatilization. It was confirmed that chlorine monofluoride, even with oxygen added, does not volatilize plutonium below 550°C. Research on gas formed during the reaction between chlorine trifluoride and UO_2, U_3O_8, UO_2F_2, and UF_4 revealed the following gas products: Cl_2, O_2, ClF, ClO_2F, ClO_3F, and UF_6. The reaction temperature had appreciable influence on the stoichiometry. Developments were made in the determination of fluorine in uranium and plutonium tetrafluorides. Research was initiated on heat transfer in fuel pins in a fluid bed. Oxidation and hydrofluorination tests on mixed dioxides gave satisfactory results. The action of chlorine trifluoride on 20 kg loads of uranium dioxide in a fluid bed indicated the need for effective cooling of the walls if the temperature of the fluid bed is to be kept at 300°C to minimize plutonium volatilization. The addition of oxygen to chlorine monofluoride or trifluoride does not lead to a significant variation in the rate of volatilization of uranium in compact pellets at 300°C. Tracer tests indicated that the volatile compounds of technetium and molybdenum may be absorbed with sodium fluoride. The same applies to neptunium hexafluoride. Magnesium fluoride also appears to possess this property for neptunium hexafluoride. The volatile compounds of ruthenium, niobium, antimony, and molybdenum formed with chlorine trifluoride at 210°C are absorbed by soda lime. The design and/or construction of a number of large assemblies (hot semi-pilot, hot thermobalance, and subassembly processing unit) continued without incident. A plutonium installation with a fluid bed was tested with uranium; the experiments proved satisfactory. (auth)

30499 (HW-SA-3622) HANFORD SALT CYCLE PROCESS. I. PLUTONIUM CHEMISTRY. Benedict, G. E.; Nixon, R. A. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). July 17, 1964. Contract AT(45-1)-1350. 20p. Dep. CFSTI.

The plutonium recovery methods in the Hanford Salt Cycle Process are described. The process can produce UO_2, PuO_2, and UO_2–PuO_2 solid solutions. The most pressing problem remaining could be solved by improving the decontamination for fission product nuclear poisons. (auth)

30500 (IS-T-158) ANION EXCHANGE BEHAVIOR AND SEPARATIONS OF METAL IONS IN DIMETHYL SULFOXIDE–METHYL ALCOHOL–HYDROCHLORIC ACID SYSTEMS. Gillette, Marcia Lehoczky (Ames Lab., Iowa). May 1967. Contract W-7405-eng-82. 93p. Dep. CFSTI.

Thesis.

The effects of dimethyl sulfoxide on the anion exchange behavior of many metals in a methanolic system with hydrochloric acid were explored. Distribution coefficients for 26 elements were determined in a mixed solvent system of dimethyl sulfoxide–methyl alcohol–0.6 M hydrochloric acid where the proportions of dimethyl sulfoxide and methyl alcohol were varied. From a graphical interpretation of these data, a theoretical explanation of the effects of dimethyl sulfoxide on the distribution coefficients was made. The role of the dielectric constant of the solvent mixture on the distribution characteristics of a metal was considered by comparison of the behavior of copper(II) in dimethyl sulfoxide–methyl alcohol–0.6 M hydrochloric acid, dimethyl sulfoxide–acetone–0.6 M hydrochloric acid, and dimethyl sulfoxide–tetrahydrofuran–0.6 M hydrochloric acid systems where the proportions of dimethyl sulfoxide present were varied from 20 to 100%. As a means of enhancing the analytical usefulness of the dimethyl sulfoxide system, the effects of the addition of water, and of the variation in acid strength on the distribution coefficients of selected metals were studied. Finally, as a measure of the analytical usefulness of the dimethyl sulfoxide–methyl alcohol–hydrochloric acid mixed solvent system in anion exchange, 27 separations of 2- and 4-component mixtures were carried out, each with quantitative results. The results emphasize the significance of the dimethyl sulfoxide–methyl alcohol–hydrochloric acid mixed solvent system as the method of choice for the anion exchange separations of many metal mixtures. (94 references). (auth)

30501 (K-1717) ORGDP FUEL REPROCESSING STUDIES. Summary Progress Report, July–December 1966. Smiley, S. H.; Pashley, J. H.; Schappel, R. B. (Oak Ridge Gaseous Diffusion Plant, Tenn.). June 12, 1967. Contract W-7405-eng-26. 75p. Dep. CFSTI.

Studies are being made of a group of processes aimed at purifying and recovering valuable uranium and plutonium from spent nuclear reactor fuels. The portion of the program considered includes two main phases: preparation of conceptual plant studies with concomitant definition of problem areas associated with the process and technology and plant design; and component development, including scale-up and testing of crucial process equipment and auxiliaries. The status of low-enrichment fuel flow sheet studies is reported, including the systems analysis project, conceptual plant studies, and sizing of the main fluid-bed reactor. The separation and purification of uranium hexafluoride-interhalogen mixtures are discussed. The fates of fission products during volatility process, the composition of irradiated fuels, criticality calculations, and the preparation of an interhalogen flow sheet for the semiworks facility are considered. Process and reactor studies, including semiworks pilot plant operation, fluidization, and sampling studies, are outlined. Corrosion testing, outlet gas filter studies, connector testing, work on a powder discharge valve, and evaluation of the ORGDP designed peripheral compressor are described. (auth)

30502 (ORNL-3950) ADSORPTION OF PROTACTINIUM ON UNFIRED VYCOR: FINAL HOT-CELL EXPERIMENTS. Goode, J. H.; Moore, J. G. (Oak Ridge National Lab., Tenn.). June 1967. Contract W-7405-eng-26. 35p. Dep. CFSTI.

Hot-cell experiments demonstrated the practicability of recovering ^{233}Pa from nitric acid solutions by adsorption on unfired, powdered Vycor. Sol-gel thoria irradiated to about 5000 Mwd/metric ton and cooled 27 days was dissolved in 13 M HNO_3–0.05 M HF–0.1 M $Al(NO_3)_3$, and the protactinium was preferentially adsorbed on unfired Vycor. (About 97% was adsorbed at a loading of 3.1 mg of ^{233}Pa per gram of glass.) It was eluted with 0.5 M oxalic acid, yielding product solutions with protactinium concentrations of about 1.5 mg/ml. Decontamination factors for zirconium-niobium, total rare earths, thorium, and uranium were 5.5, 4.8×10^3, $\geq 1 \times 10^4$, and $\geq 5.7 \times 10^2$, respectively. The ^{233}U that would be present after the decay of the protactinium would contain only 0.1 to 0.5 ppm of ^{232}U. Similar experiments showed that silica gel was also an effective adsorbent, although the capacity values and decontamination factors were lower than those obtained with the unfired Vycor. Zirconium phosphate (ZP-1) had only about half the capacity of unfired Vycor at 99% adsorption; in addition, oxalic acid elution of the protactinium adsorbed on ZP-1 was not feasible. (auth)

30503 (ORNL–4109) POSSIBLE HEAD-END PROCESSES FOR HEAVY-WATER-MODERATED ORGANIC-COOLED REACTOR (HWOCR) FUELS. Ferris, L. M. (Oak Ridge National Lab., Tenn.). July 1967. Contract W-7405-eng-26. 38p. Dep. CFSTI.

Potential processing methods for seven candidate HWOCR fuels were surveyed. Caustic decladding followed by dissolution in nitric acid (or fluoride-catalyzed nitric acid) appears to be the most promising aqueous head-end process for UC, UO_2, ThC-UC, and ThO_2-UO_2 fuels that are clad in SAP (a sintered dispersion of Al_2O_3 in an aluminum matrix). Shearing followed by acid leaching appears to be the most suitable method for UC, UO_2, and Th-U alloy fuels that are clad in zirconium (or an alloy of zirconium). A solvent extraction process could be used in conjunction with either method for the decontamination and recovery of uranium, plutonium, and thorium. Use of anion exchange for the selective recovery of plutonium from fuels that do not contain thorium is a possibility. Decladding by hydrochlorination, in a fluidized bed, followed by aqueous leaching (or by fluorination) is the basis for potential alternative processes for each of the fuels except, possibly, SAP-clad ThO_2-UO_2. (auth)

30504 (ORNL–4110) GRIND-LEACH PROCESS FOR GRAPHITE-BASE REACTOR FUELS THAT CONTAIN COATED PARTICLES: LABORATORY DEVELOPMENT. Ferris, L. M. (Oak Ridge National Lab., Tenn.). June 1967. Contract W-7405-eng-26. 52p. Dep. CFSTI.

Leaching of crushed graphite-base reactor fuels that originally contained coated particles was studied on a laboratory scale in an effort to define the conditions necessary for the adequate recovery of uranium and thorium. All experiments were conducted with unirradiated prototype fuel samples. This study indicated that the grind-leach method is of only marginal usefulness for the processing of coated-particle fuels. Major chemical problems encountered were the difficulty in achieving high uranium and thorium recoveries and the formation of soluble organic compounds during leaching. The overall conditions required for adequate recoveries made the leach solutions very dilute in uranium and thorium. Most of the work was done with prototype Peach Bottom reactor fuel, which was composed of ThC_2–UC_2 particles, each coated with a single layer of pyrocarbon, dispersed in a graphite matrix. A few experiments were conducted with crushed UHTREX fuel (graphite matrix containing UC_2 particles coated with three layers of carbon). In each instance, the fuel was ground fine enough to ensure rupture of the coated particles by rough-crushing it in a hammer mill and then pulverizing the resulting product in a double-roll crusher. Recovery of 99.9% of the uranium and thorium from the crushed (–140 mesh) Peach Bottom fuel was achieved only after leaching the fuel twice (5 hr each leach) with boiling 5 to 15.8 M HNO_3. Recoveries were inadequate after a single 5- to 24-hr leach with the amount of reagent required to produce a solution 0.2 M in U + Th (if all the ThC_2–UC_2 dissolved); usually 0.2 to 0.5% of the uranium and thorium remained in the graphite residue. Addition of HF to the nitric acid leachant did not enhance recoveries. Thorough washing of the residue after leaching was essential in obtaining maximum recoveries. During leaching, up to about 10% of the total carbon in the fuel was oxidized; however, the amount of carbon left in the leach solutions as soluble organic compounds generally corresponded to less than 1% of the carbon from the fuel. Uranium was not readily leached from crushed UHTREX fuel. Even after three 5-hr leaches with boiling 13 M HNO_3, more than 0.2% of the uranium remained with the graphite residue. (auth)

30505 (ORNL-TM–1852) FUEL AND BLANKET PROCESSING DEVELOPMENT FOR MOLTEN SALT BREEDER REACTORS. Carter, W. L.; Whatley, M. E. (Oak Ridge National Lab., Tenn.). June 1967. Contract W-7405-eng-26. 50p. Dep. CFSTI.

Evaluations of Molten Salt Breeder Reactors pointed the direction of desirable design, research, and development for improving the economic and breeding performance of these systems. In design, the conventional concept of processing fuel in facilities that are separate from the reactor plant needs to be abandoned in favor of integrating the processing operations directly into the reactor building. For the MSBR, only a small space is required adjacent to the reactor cells for processing cells. This arrangement allows significant savings in capital, operating, shipping, and inventory costs. Research and development showed that irradiated MSBR fuel can be decontaminated in a four-step process consisting of fluorination, UF_6 sorption, vacuum distillation, and reduction–reconstitution. These operations recover not only the uranium but also the LiF–BeF_2 carrier. Fluorination and sorption technologies are well developed for batchwise operation, having advanced through the pilot plant stage. However, for MSBR application, these two steps, as well as distillation and reduction–reconstitution, must be developed for continuous operation. These four unit processes are rather simple and straightforward; however, vacuum distillation requires a higher temperature (~1000°C) than encountered previously in molten salt processing. (auth)

30506 (UJV–1697) STUDY AND SEPARATION OF RUTHENIUM AND NITROSYLRUTHENIUM RADIOCOLLOID BY THE METHOD OF ULTRAFILTRATION, CENTRIFUGATION, AND ADSORPTION. Kepak, F.; Kanka, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Feb. 1967. 28p. Dep.

Conditions for the formation of a radiocolloid from ruthenium (III) and ruthenium nitrosyl(II) ions containing radioactive ^{106}Ru have been studied. The colloid formed was separated by ultrafiltration, centrifugation, and adsorption. It was found that beside the true radiocolloid, the solution also contained a non-true radiocolloid of ruthenium and ruthenium nitrosyl, formed by adsorption of the radioactive component on foreign particles. The most efficient separation of ruthenium and ruthenium nitrosyl was achieved by adsorption on ferrous hydroxide. (P.C.H.)

30507 (UJV–1733) SORPTION OF RADIORUTHENIUM IN COLLOIDAL AND IONIC STATE ON FERROUS HYDROXIDE FORMED BY ELECTRODISSOLUTION OF IRON ANODE. Kepak, F.; Kanka, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Feb. 1967. 21p. Dep.

Ruthenium(III) and nitrosylruthenium(II) both in the ionic and colloidal state, were sorbed with high efficiency on ferrous hydroxide prepared by electrodissolution of iron anode. In comparison with one-stage precipitation, higher sorption effect was reached when multistage precipitation was used. Prolongation of the sorbent-precipitation time favorably affected the efficiency of sorption. The hydroxide prepared by electrodissolution of iron anode was more effective than that prepared in the usual way. (auth)

30508 IMPROVING STRONTIUM REMOVAL FROM SOLUTION BY CONTROLLED REFLUX FOAM SEPARATION. Schonfeld, E.; Kibbey, A. H. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Nucl. Appl., 3: 353-9(June 1967). (ORNL-P-2779).

Controlled reflux was studied as a method for improving the efficiency of removing strontium from solution by foam separation. Tests were performed with solutions containing ^{85}Sr, 10^{-6} M Sr^{2+} carrier, and 90 to 100 ppM of the surfactant sodium dodecyl benzene sulfonate in either distilled water or 0.005 M NaOH to 0.005 M Na_2CO_3 solution. Nearly constant feed rates were maintained at about 40 gal/ft^2 of column cross section per hour. With these conditions, the volume reduction factor was increased to 3700 (from a value of ≈30 for nonrefluxing systems) and the strontium decontamination factor was in excess of 10^3. In general, the volume reduction was inversely proportional to the gas/liquid volume ratio but directly proportional to the percent of foam reflux; the strontium decontamination factor, however, did not change very much within the throughput range studied. (auth)

30509 TESTING OF THE SEPARATION NOZZLE TECHNIQUE IN A CLOSED CYCLE. Schuette, R.; Seidel, D. (Technische Hochschule, Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Chem.-Ing. Tech., 39: 80-4(Jan. 24, 1967). (In German).

The construction and testing of a cycle for separation of U isotopes operating with a Roots blast impervious to UF_6 is described; this is the basis of an experimental cascade of 10 members in construction. The influence of the expansion ratio in this model on elementary separation, total paring ratio, UF_6 paring ratio, UF_6 mole fraction in the exit gas and in the light and heavy fractions, the specific compression work, specific siphon volume, and specific slit width for a mixture of UF_6 and He was studied. (BBB)

30510 A FEW PROBLEMS CONCERNING THE SODA METHOD OF DISSOLVING MONAZITE AND THE PROCESS OF EXTRACTING THORIUM, CERIUM, AND LANTHANUM. Hsieh, Kuang-hua; Chang, Kai-cheng. Hua Hsueh Shih Chieh, 17: 549-51(Dec. 1963). (In Chinese).

Monazite ore is one of the major sources of thorium and rare earth elements. A dissolution experiment was conducted with the monazite of a certain area in China, and some improvements were made on the method of extracting Th, Ce, and La. (JPRS)

30511 TREATMENT OF EFFLUENTS CONTAINING RADIOACTIVE CONTAMINANTS. Mende, H. Dechema Monogr., 52: 131-42(1964). (In German).

The methods of dilution, settling, chemical precipitation or flocculation, and ion exchange are compared with evaporation as means for decontamination of effluents containing radioactive contaminants. Various types of evaporators are discussed with respect to their suitabilities for decontamination purposes. Results of optimalization of a forced-circulation evaporator with vapor-recompression indicated that decontamination by

evaporation is often more economical than by other methods. An example is given of the effects on a cost-calculation of the cost of plant and energy. Certain precautions have to be taken for safety reasons in both design and process details. Operational results of decontamination evaporators in various research establishments, with throughputs of 200 to 1300 kg of distillate per hour, demonstrate the economy and decontamination efficiency of plants of that type. (auth)

30512 CONSIDERATION OF PROCESSES IN SEPARATION COLUMNS FROM POINT OF VIEW OF APPROACH TO EQUILIBRIUM. Mercea, V.; Palibroda, N.; Grecu, E. (Inst. for Nuclear Physics, Cluj). Kernenergie, 10: 54-9(Feb. 1967). (In German).

An initial stage and a dynamically balanced region as well as their dependence on the operating conditions of the column and on the initial concentrations were determined by the aid of variables expressing the distance from equilibrium. It was found that for sufficiently long columns equivalent values of the single-stage separation factor and exchange rate can be introduced in such a way that the column can also be calculated by the usual countercurrent method. A classification of the regimes of the column in the regimes of enrichment and depletion was made by using the parameters of the countercurrent column. (auth)

30513 SEPARATION OF ISOTOPES USING COMPLEX COMPOUNDS. Pechalin, L. I.; Panchenkov, G. M. (Moscow State Univ.). Isotopenpraxis, 3: 95-7(Mar. 1967). (In Russian).

The role of the donor-acceptor interaction of molecules forming molecular compounds in the separation of isotopes by chemical exchange was determined. The simple process factors in isotope separation by chemical exchange were studied as a function of ionization potentials of the electron-donor molecule and, in the case of hydrogen isotopes, of proton affinity of the donor. ESR measurements showed that in the molecular compounds applied for separating the boron isotopes one electron is transferred. NMR measurements indicated that the exchange rate of the processes considered is extraordinarily high. From measurements of electrical conductivity of boron trifluoride complexes with anisole, it was concluded that charge transfer is present in the processes of complex forming. (auth)

30514 ^{10}B SEPARATION PLANT ON THE BASIS OF EXCHANGE DISTILLATION OF THE $(CH_3)_2O.BF_3$ COMPLEX. Bondarenko, B. R.; Vlassenko, V. A.; Gverdtsiteli, I G.; (and others). Isotopenpraxis, 3: 97-100(Mar. 1967). (In Russian).

Description is given of a separation plant that was designed, built, and put into operation on the basis of the data obtained theoretically and experimentally at the Institute of Stable Isotopes, Tbilissi. The productivity is 20 kg B per year with an enrichment of 84 at.% ^{10}B. The plant is provided with an automatic control system. (auth)

30515 ENRICHMENT OF THE ISOTOPES OF CARBON AND NEON BY GAS PHASE CHROMATOGRAPHY. PART I. Blanc, Claude; Huynh, Chanh-trung; Espagno, Lucien (Centre de Recherches, Pau, France). J. Chromatogr., 28: 177-93 (June 1967). (In French).

The chromatography of carbon monoxide and neon enabled us to obtain a considerable enrichment of the isotopes ^{12}C and ^{13}C and ^{20}Ne and ^{22}Ne without attaining a complete separation in one single stage. In order to determine the distribution of the isotopes in the chromatographic peak, a mass spectrometer was used in conjunction with the gas chromatograph. The spectrometer gave continuous information concerning the concentrations of the two isotopes. As a result of this information, a new magnitude, ρ, the factor of enrichment, is defined. This factor ρ is the product of the resolving power that characterizes the analytical efficacy of the column and the relative difference of adsorption constants of the two isotopes. (auth)

30516 ENRICHMENT OF THE ISOTOPES OF CARBON AND NEON BY GAS PHASE CHROMATOGRAPHY. PART II. Blanc, Claude; Huynh, Chanh-trung; Espagno, Lucien (Centre de Recherches, Pau, France). J. Chromatogr., 28: 194-208(June 1967). (In French).

Results obtained by gas chromatography on solid stationary phases, for the enrichment of ^{12}C and ^{13}C isotopes and ^{20}Ne and ^{22}Ne are given. The temperature and length of the column have a considerable influence on the isotopic enrichment, while the sample volume, the rate of flow of the carrier gas, and the cross section of the column are less important. The enrichment is independent of the initial isotopic concentrations in the sample. The proposed model agrees well with the results. (auth)

30517 URANIUM ORE PROCESSING RESEARCH IN AUSTRALIA. Stewart, J. R. At. Energy (Austral.), 10: No. 2, 8-12 (Apr. 1967).

A summary of research on uranium-ore processing in Australia is presented. Limitations and advantages of flotation, magnetic, gravity, and heavy medium separations; radiometric sorting; bacterial leaching; resin-in-pulp; solvent extraction; and solvent extraction-in-pulp methods are discussed. It was concluded that satisfactory recovery of U at reasonable cost by standard treatment methods is possible only in a very few cases of known Australian ores. (P.C.S.)

30518 SEPARATION OF CATIONS IN TITANIUM HEXACYANOFERRATE(II) COLUMNS. Lieser, K. H.; Bastian, J.; Hecker, A. B. H. (Technische Hochschule, Darmstadt, Ger.). Z. Anal. Chem., 228: 98-106(1967). (In German).

Quantitative separation of the ion pairs Rb^+/Cs^+, K^+/Rb^+, K^+/Cs^+, Na^+/K^+, Li^+/Na^+, Sr^{2+}/Ba^{2+}, Ca^{2+}/Ba^{2+}, Ba^{2+}/Cs^+, and Sr^{2+}/Cs^+ was achieved with HCl or ammonium chloride solutions as eluents using columns of titanium hexacyanoferrate(II). Elution of the Cs^+ ions was not possible. A partial separation of the rare earths was accomplished with this method, with yttrium being more easily eluted than the lanthanides. (auth)

30519 FISSION PRODUCTS SORPTION IN THE SUSPENSION OF NATURAL SORBENTS COAGULATED BY ELECTRIC CURRENT. Napravnik, Jiri; Kepak, Frantisek (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Jad. Energ., 13: 135-41(Apr. 1967). (In Czech).

It is shown that radioactive waste liquids can be decontaminated by sorption in natural sorbents. However, certain sorbents are not suitable for treatments in a column and should be used in a dispersed state, transformed by coagulation into well-precipitating coagulates. Sorptive properties of colloidal particles of concrete and tuff used for separating radioactive isotopes from the liquid phase were analyzed. Electric current coagulations resulted in efficient precipitation of the coagulates formed. The method was tested under semi-industrial conditions. (tr-auth)

30520 SAFETY ASPECTS IN DESIGNING WAK. Patzelt, A. (Technische Ueberwachungs-Vereine e. V., Cologne). Atomwirtschaft, 12: 215-18(Apr. 1967). (In German).

Safety provisions designed into the WAK spent-fuel-processing plant are discussed in detail. Among the physical hazards, possible criticality incidents and chemical-reaction accidents are of special interest. Measures taken to avoid such incidents include: safe geometry for all pipes, appliances, and vessels containing solutions of fissile material; safe concentrations for fluids; safe mass for handling small amounts of fissile material; and addition of neutron absorbers as a secondary safety measure in addition to concentration control. (P.C.S.)

30521 ISOTOPIC EQUILIBRIUM IN THE BF_3 SYSTEM–RF_3 COMPLEX WITH n-BUTYLPHENYL ETHER. Katal'nikov, S. G.; Vasenin, G. N. (Moscow Technological Inst.). Zh. Fiz. Khim., 41: 1174-6(May 1967). (In Russian).

Preparation of the complex of BF_3 with butyl phenyl ether is described and the composition of the complex was measured as a function of the temperature, vapor pressure, density, and viscosity. The heat of formation of BF_3 and the $C_4H_9OC_6H_5$ complex and the molar BF_3 content in the complex were estimated. A single isotopic equilibrium method was used for determining the magnitudes of boron isotope separation coefficients at 15 to 25°C. (R.V.J.)

30522 RELATION BETWEEN THE COMPOSITION OF THE COMPLEX AND THE OPTIMAL ACIDITY OF ITS EXTRACTION. Budesinsky, B. (Inst. for Nuclear Research, Prague). Collect. Czech. Chem. Commun., 32: 1688-97(May 1967). (In German).

Theoretical relations for the dependence of the optimum acidity for extraction of a complex on its composition, the distribution coefficients for electroneutral particles in chelating agents, and the concurrent reactions of reagents with protons and of metal ions with hydroxide ions are considered. The suitability of the relations derived was confirmed in extraction of metal ions by 8-quinolinol, acetylacetone, thenoyltrifluoroacetone, cupferron, and dithizone. (tr-auth)

30523 GERMAN REPROCESSING PLANT WAK. Tebbert, H.; Schueller, W.; Zuehlke, P. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirtschaft, 12: 194-200(Apr. 1967). (In German).

The design of a reprocessing facility WAK using the PUREX solvent extraction process with a capacity of 40 t/yr of slightly enriched UO_2 is described. The process, adaptable to new fuel compositions, is discussed. Individual steps for the extraction of uranium and plutonium follow the PUREX process. The final products are a uranyl nitrate solution with a concentration of some 450 g/l and a plutonium nitrate solution of some 50 g/l. The specific activity of these final products of 0.6 μCi/g U and 25 μCi/g Pu corresponds to the characteristic activity of the

respective actinides in equilibrium with their daughter nuclides. (P.C.S.)

30524 SEA-WATER TO FEED HEAVY WATER PLANT. Can. Chem. Process., 51: No. 6, 41-2; 45-6(June 1967).

The Deuterium of Canada plant at Glace Bay, which uses saline water as feed, is discussed. The plant is designed to take in 65 million gallons/day of process and cooling water to produce 200 tons a year of heavy water. The plant is a complex of gas–liquid contacting towers and heat exchangers. The "GS" process, on which it operates, is based on dual temperature isotopic exchange. The isotopic exchange depends on the reaction: H_2O + HDS → HDO + H_2O where HDO is the intermediate equilibrium product of D_2O and H_2O. The plant is essentially an integrated single-train operation, using the largest possible tower instead of parallel units. The integrated approach saves substantial capital investment and has half the operating costs of multistage units; however, Glace Bay faces heavy production losses if any section fails. The plant design has five stages of isotopic exchange, four hot–cold tower pairs plus a fifth "piggy-back" hot–cold tower. The fifth stage takes the enrichment of the product to 99.8% deuterium oxide; thus the Glace Bay plant requires no plant for electrolysis or extensive vacuum distillation. Only one small-scale distillation is required to complete purification to nuclear grade 99.95% D_2O. (D.H.M.)

30525 APPARATUS FOR DIS-ASSEMBLING NUCLEAR REACTOR FUEL ELEMENTS. Escavis, Armand; Mas, Roland (to Commissariat a l'Energie Atomique). British Patent 1,071,817. June 14, 1967. Priority date Nov. 14, 1963, France.

A device for disassembling reactor fuel elements is described. The bench is equipped with simple, but strong equipment to disassemble fuel elements of all designs. (J.C.W.)

30526 A PROCESS OF RECOVERING STRONTIUM, CESIUM, CERIUM AND RARE EARTH VALUES FROM RADIOACTIVE SOLUTIONS. (to U. S. Atomic Energy Commission). British Patent 1,070,985. June 7, 1967. Priority date Mar. 11, 1963, United States.

The process for recovery of fission products, particularly Sr, Cs, Ce, and the lanthanide rare earths is described for application to waste solution processing but is equally as applicable to ore solutions or other solutions containing the nonradioactive isotopes of the same elements. To extract the desired values from the aqueous phase into an organic phase, the solution containing the desired values is adjusted to a pH value of between 3 and 14, and the solution is then contacted with a substantially water-immiscible aliphatic hydrocarbon or halogenated hydrocarbon solution of a water-immiscible phenol and a water-immiscible alkyl ester of phosphoric acid. The preferred extractant is a kerosene solution of bis(2-ethylhexyl) phosphorate and 4-sec-butyl-2-(α-methylbenzyl) phenol. (B.L.M.)

30527 STUDY OF SODIUM PURIFICATION CARRIED OUT BY MEANS OF HIGH-EFFICIENCY DIFFUSION-TYPE COLD TRAPS. Arnoldov, M. N.; Ivanovskii, M. N.; Subbotin, V. I.; Shmatko, B. A. (Inst. of Physics and Energetics, Obninsk, USSR). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-85/47, 20p. (In Russian). (CONF-661110-12). DTIE.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna.

The principles involved in the operation of cold diffusion-type traps used for the purification of liquid-metal coolants are discussed. The results of hydrodynamic studies on diffusion-type traps are presented. Data are also given on some investigations of the removal of H_2 and O_2 from molten Na by means of cold diffusion-type traps. Results indicate that cold diffusion-type traps offer an effective method for purification under certain conditions. These traps are notable for their ability to trap large quantities of impurities with speed of operation and thorough purification being achieved. In addition, these traps possess structural advantages over circulating cold traps, such as simplicity of design and smaller size and weight. They are also less sensitive to fluctuations in flow rate and the concentration of impurities in the coolant. (auth)

EARTH SCIENCES

Geology

Refer also to abstracts 30541, 30559, and 30684.

30528 (AD-631028) FEASIBILITY OF MODELING CAVITY BEHAVIOR IN JOINTED ROCK MASSES. Final Contract Report. (Newmark, Hansen and Associates, Urbana, Ill.). Nov. 1965. Contract DA-22-079-eng-225. 141p. (AEWES-CR-1-135). CFSTI.

The general scaling relationships for nuclear effects are reviewed. For a spherically symmetric wave which approximates a measured velocity pulse at a given radius, calculations are made to compare the effects at other radii with the measured values. A discussion of the general modeling theory is followed by a discussion of the feasibility of modeling large openings in jointed media both in the laboratory and in the field. It is concluded that model tests in the field are preferred, though certain types of studies in the laboratory will be meaningful if accompanied by field studies. Application of the Hard Hat data to the design of larger openings is discussed. The destressed zone around openings in rock is described and the effect of certain parameters is studied. Consideration is given to the mechanism of rock failure at the cavity walls. The feasibility of studying free field stress wave propagation and structural interaction by using lumped parameter systems is considered. Two types of lumped parameter models now in use are described and extensions of recent work are suggested. Further work is recommended which involves field, laboratory, and theoretical studies. (TAB)

30529 (COO-1540-6) GEOCHEMICAL STUDY OF SOME MANGANESE NODULES. Bacon, Joan (Tulsa Univ., Okla. Dept. of Chemistry). June 1, 1967. Contract AT(11-1)-1540. 18p. Dep. CFSTI.

The trace element content and the accretion rates of a suite of ferromanganese nodules are determined. Inter-element relationships between Mn and Mo, Pb, and Cr are observed. Accretion rates for selected nodules average about 4 mm/10^6 years. (auth)

30530 (HN-20-1024) GROUND MOTION TRIGGERING OF LANDSLIDES. Jackson, Melvin W. (Holmes and Narver, Inc., Los Angeles, Calif.). Apr. 1967. Contract AT(29-2)-20. 20p. (CONF-670804-2). Dep. CFSTI.

For Presentation at Symposium on Wave Propagation and Dynamic Properties of Earth Materials, Albuquerque, N. Mex.

Reports of landslides, avalanches, and rockfalls due to earthquakes are collected and compared on the basis of Modified Mercalli intensities. These reports are related to ground motion accelerations on the basis of Gutenburg-Richter correlations. Such accelerations are indicative of limits for criteria that may be applied to feasibility planning of the use of large nuclear explosions. (auth)

30531 (NP-16527) OSOBENNOSTI RASPREDELENIYA STRONTSIYA-90 V RAZLICHNYKH TIPAKH POCHV EVROPEISKOI CHASTI SSSR V 1961 G. (Specific Features of ^{90}Sr Distribution in Different Soils in the European Region of the USSR in 1961). Tyuryukanova, E. B.; Pavlotskaya, F. I.; Baranov, V. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1965. 19p. (In Russian). Dep.

Strontium-90 was determined in various soils, at depths from 0 to 150 cm, in grassy and dry steppe and young taiga regions. The distribution of this nuclide was found to depend on several factors, e.g., on the type of soil, especially the organic content, stratification, and nature of the vegetation. The ^{90}Sr content was maximum in the high-humus, black soils. In the peaty podzols it was concentrated in the upper part of the layer under the friable, slightly decomposed litter. In the black earth and peaty soils, ^{90}Sr was distributed more uniformly. In swampy soils it was concentrated in the humus layer and was practically absent from the gley. In salt marsh soils it was found in the salty crust and the upper part of the gypsum layer. (TTT)

30532 (ORO-490-2) MATHEMATICAL MODELS FOR THE DISPERSION OF RADIONUCLIDES IN AQUATIC SYSTEMS. Armstrong, Neal E.; Gloyna, Earnest F. (Texas Univ., Austin). May 1967. Contract AT(11-1)-490. 19p. (CONF-670503-16). Dep. CFSTI.

From 2nd National Symposium on Radioecology, Ann Arbor, Mich.

A general equation is presented which describes radionuclide transport in terms of hydraulic dispersion and convection and by detention systems which sorb and release. A model to describe sorption by various substrates using the concentration gradient between the equilibrium activity in the substrate and the actual activity is also presented. Linear and non-linear equations are discussed concerning accuracy of prediction and effect on ease of obtaining a solution. It was found that the linear equation allowed an easy solution, while the non-linear form permitted ready comparison of sorption mechanisms between systems. (auth)

30533 (TEI-869) PRELIMINARY REPORT ON BUREAU OF MINES YELLOW CREEK CORE HOLE NO. 1, RIO BLANCO COUNTY, COLORADO. Carroll, R. D.; Coffin, D. L.; Ege, John R.; Welder, F. A. (Geological Survey, Denver, Colo.). Mar. 1967. 41p. Dep. CFSTI.

Includes Charts.

Analysis of geologic, hydrologic, and geophysical data obtained in and around Yellow Creek core hole No. 1, Rio Blanco County, Colorado, indicate a 1,615-foot section of oil shale was penetrated by the hole. Geophysical log data indicate the presence of 25 gallons per ton shale for a thickness of 500 feet may be marginal. The richest section of oil shale is indicated to be centered around a depth of 2,260 feet. Within the oil shale the interval 1,182 to 1,737 feet is indicated to be relatively structurally incompetent and probably permeable. Extension of available regional hydrologic data indicate the oil shale section is probably water bearing and may yield as much as 1,000 gallons per minute. Hydrologic treating in the hole is recommended. (auth)

30534 (TEI-870) PRELIMINARY REPORT ON THE GEOLOGY, GEOPHYSICS, AND HYDROLOGY OF USBM/AEC COLORADO CORE HOLE NO. 2, PICEANCE CREEK BASIN, RIO BLANCO COUNTY, COLORADO. Ege, John R.; Carroll, R. D.; Welder, F. A. (Geological Survey, Denver, Colo.). Mar. 1967. 57p. Dep. CFSTI.

Approximately 1,400 feet of continuous core was taken between 800 and 2,214 feet in depth from USBM/AEC Colorado core hole No. 2. The drill site is located in the Piceance Creek basin, Rio Blanco County, Colorado. From ground surface the drill hole penetrated 1,120 feet of the Evacuation Creek Member and 1,094 feet of oil shale in the Parachute Creek Member of the Green River Formation. Oil shale yielding more than 20 gallons per ton occurs between 1,260 and 2,214 feet in depth. A gas explosion near the bottom of the hole resulted in abandonment of the exploratory hole which was still in oil shale. The top of the nahcolite zone is at 1,693 feet. Below this depth the core contains common to abundant amounts of sodium bicarbonate salt intermixed with oil shale. The core is divided into seven structural zones that reflect changes in joint intensity, core loss and broken core due to natural causes. The zone of poor core recovery is in the interval between 1,300 and 1,450 feet. Results of preliminary geophysical log analyses indicate that oil yields determined by Fischer assay compare favorably with yields determined by geophysical log analyses. There is strong evidence that analyses of complete core data from Colorado core holes No. 1 and No. 2 reveal a reliable relation between geophysical log response and oil yield. The quality of the logs is poor in the rich shale section and the possibility of repeating the logging program should be considered. Observations during drilling, coring, and hydrologic testing of USBM/AEC Colorado core hole No. 2 reveal that the Parachute Creek Member of the Green River Formation is the principal aquifer and the water in the Parachute Creek Member is under artesian pressure. The upper part of the aquifer has a higher hydrostatic head than, and is hydrologically separated from, the lower part of the aquifer. The transmissibility of the aquifer is about 3500 gpd per foot. The maximum water yield of the core hole during testing was about 500 gpm. Chemical analyses of water samples indicate that the content of dissolved solids is low, the principal ions being sodium and bicarbonate. Although the hole was originally cored to a depth of 2,214 feet, the present depth is about 2,100 feet. (auth)

30535 IONIUM DATING OF IGNEOUS ROCKS. Kigoshi, Kunihiko (Gakushuin Univ., Tokyo). Science, 156: 932-4(May 19, 1967).

Local fractionation of uranium and thorium, between minerals within a sample of igneous rock at the time of crystallization, makes it possible to date its solidification by use of ionium and uranium. Results on samples of granite, pumice, and lava suggest that this method of dating is reliable. (auth)

30536 K-Ar AND Rb-Sr MEASUREMENTS ON P-207, THE U. S. GEOLOGICAL SURVEY INTERLABORATORY STANDARD MUSCOVITE. Lanphere, Marvin A.; Dalrymple, G. Brent (U.S. Geological Survey, Menlo Park, Calif.). Geochim. Cosmochim. Acta, 31: 1091-4(June 1967).

Potassium-argon analyses of P-207, the U. S. Geological Survey

standard muscovite, in twenty-four laboratories and rubidium–strontium analyses in ten laboratories indicate that for material of this type the average interlaboratory precision for K–Ar ages is 2.6% and for Rb–Sr ages is 3.4%, and the average intralaboratory precision for K–Ar ages is 1.6% and for Rb–Sr ages is 2.9%. (auth)

30537 GEOLOGICAL EVIDENCE FOR A PULSATING GRAVITATION. Machado, F. (Oxford Univ.). Nature, 214: 1317-18 (June 24, 1967).

Dirac (1937) suggested that the gravitation "constant" f could have been decreasing with time. Such a decrease has important implications, such as expansion of the Earth's volume and a decrease of solar radiation. Expansion would produce regression of the oceans and fracturing of the crust, with apparent migration of continents, and decreased radiation would cause cooling of climate. This state of affairs certainly occurred during some intervals of the Earth's history. Expansion, however, does not explain thickening of the crust in orogenic belts of the production of oceanic transgressions, both of which occurred. Also warm climates appear to have alternated with cold climates. The present paper reviews what the geological evidence really suggests for variation of f. Ocean transgressions and regressions, together with climate variation, suggest a pulsating gravitation "constant," with maxima at Carboniferous and Cretaceous, and minima at Triassic and present time. The tectonic phenomena are more complicated. It is concluded that, notwithstanding certain difficulties of interpretation, the geological record suggests a pulsating variation of f, rather than a monotonic decrease. An attempt is made to deduce quantitative values. (UK)

30538 PHYSICS AND CHEMISTRY OF THE EARTH, VOL. 7. Ahrens, L. H.; Press, F.; Runcorn, S. K.; Urey, H. C. (eds.). Oxford, Pergamon Press, 1966. 337p. 105s.

Section headings are: Orogenic fold-belts and a hypothesis of earth evolution (R. Dearnley, Institute of Geological Sciences, S. Kensington, London)–Earthquake energy and magnitude (M. Bath, Uppsala University, Sweden)–Meteoritic, solar, and terrestrial rare earth distributions (L. A. Haskin et al., University of Wisconsin and General Dynamics Corp., San Diego). (UK)

30539 RADIOINDIKATORNYE METODY ISSLEDOVANIYA DVIZHENIYA PODZEMNYKH VOD. (Radiotracer Methods in the Investigation of Underground Water Flow). Churaev, N. V.; Il'in, N. I. Moscow, Atomizdat, 1967. 124p.

Theoretical principles of the radiotracer method for the investigation of streams, the results of laboratory tests, and methods for the introduction of field radiotracer measurements are examined. A review is given of the work on the use of radiotracer methods in hydrogeology, hydrology, and hydrotechniques. (tr-auth)

Meteorology

Refer also to abstracts 30659 and 31955.

30540 (AECL-2682) CONCEPT OF A STANDARD SITE. Barry, P. J. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Mar. 1967. 16p. Dep. CFSTI. AECL $0.50.

Containment limits the release of radioactive material from a reactor to the atmosphere. Correct siting increases the probability that the material will be well diluted before it reaches centers of population. The differences between the atmospheric dispersion rates at different power reactor sites are insignificant. A standard site is therefore proposed. The new approach to dispersion estimates the probability that any given rate will occur. With the information in this form a properly calculated risk can be taken when the required degree of containment is specified. The results of a direct experimental determination of the required probabilities are presented. (auth)

30541 (EUR-3463.i) C.C.R. ISPRA: CARATTERISTICHE DEL SITO. (Ispra JRC: Site Characteristics). (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Feb. 23, 1967. 64p. (In Italian). Dep.

The main features of the Ispra site concerning the meteorological, geological, hydrological, demographical and ecological aspects are described. The information has been gathered partly from reports available at the Ispra Euratom JRC, partly from the Ufficio Provinciale di Statistica di Varese, and partly from inquiries performed directly by the Site Survey Meteorology Section of the Protection Service. (auth)

30542 (MIT-2241-31) PLANETARY TRANSPORT PROCESSES IN THE UPPER ATMOSPHERE. Annual Progress Report, May 15, 1967. Newell, Reginald E. (Massachusetts Inst. of Tech., Cambridge. Dept. of Meteorology). Contract AT(30-1)-2241. 19p. Dep. CFSTI.

Progress is reported on the studies of the physical cause of the biennial oscillation in zonal wind and temperature in the tropical stratosphere. A complete list of publications and reports is also included. Observational data and theories pertinent to problems of the circulation of the stratosphere, mesosphere, and thermosphere have been studied. These include: biennial oscillation in zonal wind and temperature in the tropical stratosphere; year to year modulation in eddy fluxes in the stratosphere; spring maximum in ozone amount (and in concentration of radioactivity in ground level air) due to the enhancement of the vertical flux into the stratosphere from the troposphere; interaction of the upper and lower layers of the atmosphere; vertical propagation of quasi-geostrophic planetary waves; atmospheric tides; and the transfer of heat and momentum in the thermosphere by large scale motions. (F.S.)

30543 (NP-16525) K VOPROSU OB IZUCHENII FORM POSTUPLENIYA NEKOTORYKH PRODUKTOV DELENIYA NA ZEMNUYU POVERKHNOST'. (Different Processes of Deposition of Some Fission Products on the Ground). Pavlotskaya, F. I.; Zatsepina, L. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1965. 13p. (In Russian). Dep.

The character of the distribution of the radioactive fission products between soluble and nonsoluble parts of the radioactive fallout depends on the chemical properties of the isotopes, quantity of the solid phase, type of radioactive fallout, and their physical states. The form of the occurrence of radioisotopes (cation, anion, neutral) in the soluble parts of the radioactive fallout is determined by the chemical state of the element and the chemical state of the solution. The degree of mobility of the radioactive isotopes, accumulated in the solid phase, depends on the chemical state of the solid phase, the properties of the isotope, and the time, from the moment of the nuclear explosion to the deposition of the fallout on the ground. The further behavior of the radioisotope on the ground is determined, aside from the property of the compound, by the form in which it is released from the atmosphere, combined with the natural conditions in which it falls. (tr-auth)

30544 (NYO-2174-56) RADIOACTIVE FALLOUT IN OVER-OCEAN AEROSOLS. Noshkin, Victor E. (Woods Hole Oceanographic Institution, Mass.). June 9, 1967. Contract AT(30-1)-2174. 24p. Dep. CFSTI.

Observations from the collection and analysis of over-ocean radioactive aerosols are presented. The integrated concentration of ^{137}Cs collected over-ocean from the equator to 40°N does not appear to differ from the ^{137}Cs integrated over comparable latitudes on land. Within this latitude band there appear to be regions of higher and lower concentration per cubic meter over-ocean as compared to over-land. During periods before and substantially after recent nuclear tests the $^{144}Ce/^{137}Cs$ ratio from samples collected for a three-day period over-ocean showed no indication of fractionation both as a function of latitude and time, its decrease with time corresponding to that expected from decay. Comparing these values to those observed over-land suggests fractionation may be occurring during the deposition of ^{144}Ce and ^{137}Cs over some of the Northern Hemisphere cities. The patterns of fresh fallout deposition can be traced both as a function of time and position. The first arrival of debris from the May 1965 test by the Chinese was detected farther south over-ocean than over-land. Correlation of fallout isotopes and cosmic produced ^{7}Be possibly shows over-ocean collection of aerosols of different origin as a function of latitude. Indications point to an influx of stratospheric air into the northern equatorial over-ocean troposphere during some seasons, but not necessarily on an annual cycle. (auth)

30545 (NYO-3654-2) PROJECT STREAK. Quarterly Progress Report No. 2. Seitz, Harold (Isotopes, Inc., Westwood, N. J.). Apr. 30, 1967. Contract AT(30-1)-3654. 10p. Dep. CFSTI.

A model was prepared to simulate more realistic injections of ^{90}Sr into the meridional plane of the atmosphere during the two-year period, 1961 and 1962. Observed data of atmospheric distributions and surface deposition for ^{90}Sr provide a better basis than ^{185}W data for model performance evaluation. Tests were also conducted with the four-season model to achieve a spring leak in fallout comparable to observed data. Tests on naturally produced ^{7}Be will be conducted with the model. Production and decay equations for this radioisotope will be incorporated into the model. (F.S.)

30546 (SC-CR-67-2534) PARTICLE FALL AND DISPERSION IN THE ATMOSPHERE. Semi-Final Report, September 9, 1966–January 31, 1967. Hage, K. D. (Travelers Research Center, Inc., Hartford, Conn.). Feb. 1967. Contract 48-4932. 40p. Dep. CFSTI.

For Sandia Corp. [Albuquerque, N. Mex.]

Program modifications, tests, and computational aids are described for a particle transport and dispersion model that was

developed previously as a tool in investigations of possible hazards associated with aborted missions or orbital-decay reentries of space vehicles using nuclear fuels. The major program modifications are: an increase in the scope of the simulated wind fields in the model, and an improvement in the method of computing deposit densities. The minimum particle size that can be used in the model is found to be about 3 microns. Suggestions are given for the specification of time-step interval, subdivision criteria, simulated wind field, and program option selections. (auth)

30547 (TID-23860) SYSTEM FOR LARGE VOLUME AEROSOL SAMPLING IN THE STRATOSPHERE USING ELECTROSTATIC PRECIPITATION. Solon, Leonard R.; Lilienfeld, Pedro; DiGiovanni, Hugo J. (Del Electronics Corp., Mount Vernon, N. Y.). Dec. 1966. Contract AT(30-1)-2363. 76p. Dep. CFSTI.

An instrumental system for securing aerosol samples in the stratosphere by electrostatic precipitation was developed. The system is designed to be balloon borne to altitudes between 30 km and 45 km and to collect with high efficiency the aerosol content of the stratosphere at these altitudes. Volumetric sampling rates of one meter^3/sec^{-1} ambient air are obtained with the sampling configuration with collection efficiency in excess of 95 percent for particles between .01 microns (mmd) and 2 microns (mmd). Specially developed associated instrumentation for altitude and air flow measurement points to an important versatility in the application of gas discharges for low-pressure (or high altitude) altimetry and anemometry over a very wide range of air densities and temperatures. The theory, operation, and performance of the aerosol sampling system and associated subsystems are described. Certain new observations of low-density corona physics phenomena are reported and potential applications to other areas of research and technology are indicated. (auth)

30548 LONG-LIVED RADIOACTIVITY OF AIR AND FALLOUT IN THE G.D.R. IN 1964 AND 1965. Zier, M. (Meteorologische Observatorium, Dresden). Kernenergie 10: 59-64 (Feb. 1967). (In German).

The results of measurements made by the Meteorological Service of the G.D.R. for determining the long-lived radioactivity of air and fallout in 1964 and 1965 are given. The mean annual value of air activity was 0.2 pCi/m^3 in 1965, i.e., only $\frac{1}{20}$ of the 1963 value. Radioactive fallout is related to air activity and the amount of atmospheric precipitations and is 2 to 4 times higher at the mountain stations (Brocken and Inselsberg) than in the flat-land stations. For days free from precipitation the fallout activity increases nearly proportionally to air activity. Fission products from the two Chinese tests were determined 10 and 7 days after the explosions, respectively. (auth)

30549 BULLETIN OF THE ATMOSPHERIC RADIOACTIVITY, NO. 45, APRIL-JUNE 1966. Taiki Hoshano Kansoku Seiseki, No. 45, 1-63(Apr.-June 1966). (In Japanese).

Data are tabulated for the second quarter of 1966 as follows: measurements of temporary standard sample (U_3O_8) at each station; mean radioactivity in rain at fixed time daily; observed radioactivity in rain at fixed time daily; and observed radioactivity in airborne dusts collected by dust collector. (P.C.S.)

30550 CHRONOLOGY OF ANCIENT EGYPT. Suess, Hans E. (Univ. of California, San Diego, La Jolla). Z. Phys., 202: 1-7 (1967). (In German).

A set of careful radiocarbon measurements of historically dated samples from ancient Egypt (approx. 2500 to 3300 B.C.) show excellent agreement with the historically expected age if the conventional ^{14}C dates are corrected for variations in the atmospheric ^{14}C level over the past millenia. These variations have been established by calibration measurements on dendrochronologically dated bristlecone wood (Pinus aristata), and are in the range of several percent, corresponding to age deviations of several hundred years. (auth)

Mineralogy

30551 U, Th, AND K IN THE CANADIAN PRECAMBRIAN SHIELD AND POSSIBLE MANTLE COMPOSITIONS. Shaw, D. M. (McMaster Univ., Ontario). Geochim. Cosmochim. Acta, 31: 1111-13(June 1967).

Some analytical results from the Geological Survey of Canada are given. These are related to heat production rates, continental shelf considerations, and Earth's mantle composition. (UK)

30552 OCCURRENCE OF RARE ELEMENTS IN THE COPPER-BEARING MARL SERIES OF THE LOWER ZECHSTEIN IN THE GRODZIEC SYNCLINE. Kanasiewicz, Jerzy (Zaklad Zloz Pierwiaskow Rzadkich i Promienioworczych, Warsaw). Kwart. Geol., 11: 113-17(1967). (In Polish).

The results of researches on copper-bearing marls of Lower Zechstein age in the Grodziec syncline are reported. The content of such elements as rhenium, selenium, molybdenum, uranium, and copper was determined. The series of copper-bearing marls of Lower Zechstein age is characterized by the highest content of the elements investigated, as compared with other beds of the Lower Zechstein. For this series mean contents of the investigated elements were calculated. Distribution of the elements in vertical profile of the beds considered and along their extension is irregular. Some correlations were noted only between rhenium and copper (r = +0.69), and selenium and uranium (r = +0.45). It may be assumed on the basis of the works conducted that the association of the elements occurring in copper-bearing marl series originated due to the favorable physical, chemical, and facial conditions that existed in the Zechstein marine basin at the time of deposition of the beds under consideration. (auth)

Oceanography

Refer also to abstracts 30532, 30823, and 32057.

30553 (NP-16526) K OTSENKE OBSHCHEGO KOLICHESTVA STRONTSIYA-90 V MIROVOM OKEANE. (Estimate of the General ^{90}Sr Content in the World Ocean). Popov, N. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1965. 12p. (In Russian). Dep.

Most of the ^{90}Sr in existence is believed to be contained in the oceans because the majority of the tests were carried out at the sea; in addition, several underwater tests were also made in the Pacific. During the last few years, direct measurements of the ^{90}Sr content of the sea water have been made during the trips of various research ships. The ^{90}Sr content of the Pacific was found to vary from 300 to 100 mCi/km^2 but in several locations in the Southern hemisphere, very low values of only 4 mCi/km^2 were found. The concentration in the Antarctic Ocean amounted to about 30 mCi/km^2; in the Indian Ocean values of 50 and 85 mCi/km^2 were reported. For the Atlantic Ocean, 17 and 27 mCi/km^2 were reported for 1957 and 1958, respectively. As the contamination of the Atlantic Ocean's waters comes primarily from the stratosphere, the accumulation of the fission products is slow and at the end of 1961, the concentration was estimated at about 38 mCi/km^2 in the North Atlantic and about 20 mCi/km^2 in the South Atlantic. The total ^{90}Sr content of the world's oceans by the end of 1961 was estimated at about 10 mCi. Even though wide areas have not been checked, the regions covered included most of the potentially contaminated zones. The total universally accepted ^{90}Sr content of the Earth resulting from bomb tests was estimated at 9.2 mCi in 1958. (TTT)

30554 (UCSD-34P127) STUDY OF THE DEEP CIRCULATION AND DEEP FISH POPULATIONS IN THE PACIFIC OCEAN. Annual Report. Isaacs, John D.; Schwartzlose, Richard A. (Scripps Institution of Oceanography, La Jolla, Calif.). May 9, 1967. Contract AT(11-1)-34. 16p. Dep. CFSTI.

In the last two years new insight has been gained on the conditions of the ocean floor with important implications to the science and technologies of both the deep sea and the surface regions. The deep sea floor off Southern and Baja California was found: to be subject to coherent and measurable steady and tidal currents; to harbor a large population of active creatures including very large climax predators; and to yield a novel and promising fundamental entree into some of the vital problems of organic turnover of the organisms in the near-surface layers. These discoveries have emerged as a result of the studies of the benthic conditions by the employment of three types of autonomous (free vehicle) instruments developed at Scripps that have been deployed to the deep ocean floor in exploratory surveys. (auth)

30555 (USNRDL-TR-67-50) COMPARISON OF THEORETICAL OCEAN DIFFUSION MODELS. Smith, D. R. (Naval Radiological Defense Lab., San Francisco, Calif.). May 15, 1967. 34p.

Since several diffusion equations exist for describing horizontal diffusion from a point-source release of material in the ocean, a comparison of these equations is made in order to determine the one which would give the most conservative answers for purposes of evaluation of radiological hazards. This comparison can be made in terms of the maximum spatial and temporal coordinates of a given concentration. It is found that these coordinates can be expressed in terms of the ratio of the initial concentration to the given concentration raised to some power. Equations are derived for the case of a continuous release, and a similar analysis is made for the equilibrium situation. (auth)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 30528, 30530, 30545, and 30651.

30556 (AD-630654) TRANSFORMATIONS FOR SCALING OF CLOSE-IN PRESSURES FROM NUCLEAR EXPLOSIONS. Lutzky, M.; Lehto, D. (Naval Ordnance Lab., White Oak, Md.). Mar. 9, 1966. 18p. (NOLTR-66-12). CFSTI.

Abstract scaling methods for pressure-distance curves for a simplified model of a nuclear explosion are presented. It is found that different scaling variables are useful in different regimes, one set yielding a single dimensionless curve in the close-in region, while another set yields a single curve in the limit of large distances. These scaling methods are exact for an ideal gas, except for deviations caused by the second shock. For real air, additional discrepancies are introduced but the scaling is still sufficiently accurate to be useful. (TAB)

30557 (AD-641311) CLOSE-IN EFFECTS OF NUCLEAR EXPLOSIONS. PART II. ANALYSIS OF GROUND SHOCK FROM NUCLEAR SURFACE BURSTS ON ROCK. Baron, Melvin L.; Christian, Charles E.; Skidan, Oleg (Weidlinger (Paul) Consulting Engineer, New York). Feb. 1966. Contract DA-49-146-XZ-128. 107p. (DASA-1388-11). CFSTI.

A study of various phenomena which are generated in rock like media by a nuclear surface burst is presented. Three principal regions of interest are considered: an extreme close-in region in the neighborhood of Ground Zero in which the medium is represented by a hydrodynamic model; a transition region in which the medium is represented by an inelastic solid material model which exhibits energy dissipation; and a nearly elastic region in which inelastic energy dissipation is assumed very small and the material acts elastically. Computer codes have been developed for each of the regions. Numerical results are presented for the case of a two megaton surface burst on a tuff medium. (TAB)

30558 (CONF-660904-Vol.1 and 2, pp 496-508) VENT GAS TREATMENT PLANT. Ackerman, J.; Bundrick, R.; Cowles, J.; (and others) (California Univ., Livermore. Lawrence Radiation Lab.).

A design of a vent gas treatment plant for Project Dribble is presented. The methods of removal of radioactive particulates and the control of gas release rate are discussed. The portability of the plant to prevent seismic shock wave damage is considered. (M.L.S.)

30559 (HNS-1229-47(Suppl.1)) SPATIAL DISTRIBUTION OF RADIOACTIVE MATERIALS AROUND THE CAVITY OF AN UNDERGROUND NUCLEAR DETONATION. Lynch, Edward J.; Cullimore, Coridon N. (Hazleton-Nuclear Science Corp., Palo Alto, Calif. Bradberry (Carroll E.) and Associates, Inc., Los Altos, Calif.). Mar. 18, 1965. Contract AT(29-2)-1229. 30p. Dep. CFSTI.

Estimates are presented of spatial distributions of radionuclides around detonations in salt, granitic rock, and carbonate rock. The results indicate that salt is probably the best medium for forming a stable cavity which will contain almost all of the radionuclides. Granitic rock may also form an initially stable cavity, but the long period required for the cavity to cool increases the chance that the chimney will collapse and permit the escape of some of the gaseous radionuclides. A carbonate detonation poses the greatest problem. Unless burial is deep, a carbonate shot may vent; even for a deep burial there will be widespread dissemination of radiocontaminants in the rock around the shot point. (auth)

30560 (ORNL-TM-1886) CHEMICAL APPLICATIONS OF NUCLEAR EXPLOSIONS (CANE). Progress Report, January 1-March 31, 1967. Blake, C. A. Jr.; Crouse, D. J. (comps.) (Oak Ridge National Lab., Tenn.). June 2, 1967. Contract W-7405-eng-26. 17p. Dep. CFSTI.

In studies of variables affecting ^{106}Ru contamination of cement copper, little change in the amount of contamination was observed with change in agitation rate during cementation. Attempts to preferentially dissolve ^{106}Ru from cement copper were not successful. Of eleven radionuclides tested, only ^{95}Zr-Nb, ^{59}Fe, and ^{110}Ag were extracted significantly by the copper extractant, LIX-64. Since the concentrations of these radioisotopes in the leach liquor are expected to be very low, solvent extraction of copper with LIX-64 should produce a copper product solution essentially free of radionuclides. Contacting hot shale oil with radioactive debris from an underground test shot contaminated the oil with radionuclides. The principal contaminant was ^{106}Ru. The measured rate of tritium-hydrogen exchange in water vapor-methane systems in a 1-liter glass vessel at room temperature and atmospheric pressure is 2.3×10^{-8} [HTO]^2 mCi/liter-day when the tritium concentration is in the range of 10 to 50 mCi/liter. A study is being made of the thermal stability of various actinide compounds which might be of interest in transplutonium element production with thermonuclear devices. Thermogravimetric and differential thermal analysis equipment has been installed in a glove-box facility. Operability of the equipment has been demonstrated successfully in studies on europium and plutonium oxides. (auth)

30561 (TID-23533) FINAL INVESTIGATIONS OF WATER-WELL COMPLAINTS RELATED TO SALMON EVENT IN TATUM SALT DOME AREA, LAMAR COUNTY, MISSISSIPPI. Technical Letter: Dribble-46, Suppl. 1. Taylor, R. E. (Geological Survey, Denver, Colo.). Dec. 19, 1966. 30p. Dep. CFSTI.

On October 22, 1964, the day of the 5-kiloton nuclear detonation (Salmon Event), the U.S. Geological Survey and the U.S. Atomic Energy Commission began to receive inquiries and complaints about the operation of water wells and one spring in the area around Tatum dome. On the same day, the Survey began to investigate these complaints. Inquiries and complaints were received until December 1965 and the investigations were completed in May 1966. A total of 139 inquiries and complaints was filed on 142 wells and 1 spring. The difference between this number (139) and the number of wells and one spring (143) is explained by the fact that four complainants reported two wells each. Inspection of screens removed from 44 closed wells (31 percent of all complaints) revealed that closed-screened wells had incurred no visible structural damage but that a few motors had been damaged. The problems in most wells were due to normal well deterioration and declining water level. A preshot water-well inventory is probably one of the best means of lessening the number of complaints, of facilitating postshot investigations, and of documenting water and well conditions. (auth)

30562 (UCID-15145) USE OF HIGH EXPLOSIVES FOR SPRINGING UNDERGROUND CAVITIES. Butkovich, T. R. (California Univ., Livermore. Lawrence Radiation Lab.). May 24, 1967. Contract W-7405-eng-48. 6p. Dep. CFSTI.

A method, developed by analyzing a large number of events for which depth of burst, energy yield, and cavity radius measurements were made, shows that in order to spring an underground cavity, the ratio between cavity pressure and overburden pressure should be between 1 and 2.2 times the overburden pressure. Data for alluvium, saturated tuff, granite, and salt give average overburden densities and the ratio between cavity pressure and overburden pressure. An example using the method described is completed for springing a 5m radius cavity from a 0.5 m spherical cavity at a depth of 500 ft in salt. (F.S.)

30563 (UCRL-50008-67-2) PLOWSHARE PROGRAM. Vol. II. No. 5, February 1-April 30, 1967. Rabb, David D. (comp.) (California Univ., Livermore. Lawrence Radiation Lab.). Contract W-7405-eng-48. 18p. Dep. CFSTI.

Report abstracts, present status of field projects, and related theoretical studies in a review of the Plowshare Program events from February 1, 1967 to April 30, 1967 are presented. (D.C.C.)

30564 (UCRL-50213) RESULTS FROM SEDAN POSTSHOT DRILLING. Hansen, Spenst M. (California Univ., Livermore. Lawrence Radiation Lab.). Dec. 1966. Contract W-7405-eng-48. 39p. Dep. CFSTI.

Four holes were drilled near the bottom of the Sedan nuclear crater at the Nevada Test Site. Punch core samples were recovered periodically during the drilling. Density logs, caliper logs, radiation logs, and temperature logs were run in the holes. The true crater surface was encountered at the depth of 822.4 ft below the preshot surface ground zero (192.4 ft below the point of detonation) in the hole nearest the crater center, and at shallower depths in the remaining three holes. The true crater surface is approximately hemispherical in shape. Zones of increased density exist in the lower portion of the fallback and in adjacent regions outside the true crater surface. Maximum densities encountered are slightly greater than 2.2 g/cm^3 and represent an increase of approximately 20% above the preshot density. The existence of open concentric fractures outside the true crater surface is supported by evidence from gamma radiation logs and air circulation loss. Radial fractures which transect the concentric fractures may also exist. Elevated temperatures resulting from heat deposited by the nuclear explosion decrease laterally outward from the center of the crater. The region of highest temperature was encountered near the crater center at depths of 85 to 243 ft beneath

the shot point. The maximum temperature recorded was 169.8°F. Radiation logs show the occurrence of local zones of high and low radioactivity in each of the drill holes. The general trend is for gamma radioactivity to increase with depth to a maximum about midway between the shot point and the true crater surface. Tritium analyses were made of punch core samples from the hole nearest the crater center. The results indicate that the bulk of the tritium remaining within the fallback lies above the shot point with the relative concentration decreasing rapidly and regularly with greater depth. Punch core samples are not sufficiently distinctive to characterize the part of the crater from which they were taken. A greater amount of disaggregation of cemented alluvium, however, was noted inside the true crater surface. (auth)

30565 (AD-637416) CHARACTERISTIC AND COMPARISON OF THE DESTRUCTIVE FACTORS OF NUCLEAR WEAPONS OF SMALL AND HIGH POWER. Janik, Josef. Translated from Przegl. Wojsk Ladowych, 5: 125-40(1963). 21p. (FTD-TT-64-1369). CFSTI.

Data concerning the explosions of nuclear weapons are presented, and the basic parameters of the destructive factors of low and high yield nuclear explosions are compared. High power yield explosions refer to nuclear charges of explosive power equal to or greater than one megaton. The energy released by a nuclear explosion divides its destructive power as 50% mechanical destructive force or shock wave, 35% thermal radiation, and 15% penetrating radiation and radioactive contamination of terrain. Comparisons of radioactive cloud formation, shock wave magnitude and effective radius, thermal radiation dispersion, contamination of terrain, and cratering characteristics are presented for various size nuclear explosions. (D.C.C.)

30566 CONDITIONS FOR THE FORMATION OF RADIOACTIVE FALLOUT PARTICLES AND FRACTIONATION OF ISOTOPES DURING AN UNDERGROUND CRATERING NUCLEAR EXPLOSION. Izral, Yu. A. Dokl. Akad. Nauk SSSR, 169: 573-6 (July 21, 1966). (In Russian).

The changes in volume, pressure, and temperature for craters formed in alluvium by the 100-kt Sedan cratering explosion were determined. Temperature variation was used to calculate fractionation in different zones. Maximum fractionation occurred in the upper part of the cloud and minimum fractionation in the crater, where fallout is formed in the zone in which a high temperature is maintained for a long time. (F.S.)

30567 PRODUCTION OF ISOTOPES FROM THERMONUCLEAR EXPLOSIONS. Taylor, Theodore B. (to U. S. Atomic Energy Commission). U. S. Patent 3,331,744. July 18, 1967.

A method for producing isotopes by placing an element in the proximity of a thermonuclear bomb and irradiating the element with neutrons from the bomb when the bomb is exploded is described. (AEC)

Facilities and Equipment

Refer also to abstracts 30520, 30558, 30656, 30657, 30673, 30825, 31197, 31347–31349, 31913, and 31925.

30568 (BAW-1280-43) SODIUM-HEATED STEAM GENERATOR DEVELOPMENT. Quarterly Progress Report, October–December 1966. (Babcock and Wilcox Co., Barberton, Ohio. Boiler Div.). Feb. 1, 1967. Contract AT(11-1)-1280. 18p. Dep. CFSTI.

Detail design of the Prototype Steam Generator is approximately 99% complete and fabrication approximately 85% complete when a fabricating problem occurred. A small spot was noticed on one of the superheater riser tubes being prepared for welding to the superheater outlet tubesheet. This spot proved to be an overheated area from improper control of a hot forming operation. A sample was removed and metallographic examination disclosed oxide filled cracks or penetrations to a depth of approximately one-third the tube wall thickness. All work on the pressure parts of the steam generator was held up until it could be determined how many additional tubes might have been overheated. A procedure was worked out for cleaning and inspecting each tube in the steam generator throughout the entire length where any hot work had been performed. This inspection is now in progress. (auth)

30569 (BAW-1280-44) SODIUM-HEATED STEAM GENERATOR DEVELOPMENT. Quarterly Progress Report, January–March 1967. (Babcock and Wilcox Co., Barberton, Ohio. Boiler Div.). June 1, 1967. Contract AT(11-1)-1280. 20p. Dep. CFSTI.

Engineering work on the Prototype Steam Generator is complete except for routine changes to detail drawings, final design of test instrumentation to be installed in the steam generator, and the operating instruments and test procedure. Fabrication of the Prototype Steam Generator has been held up by the inadvertent overheating of a superheater riser tube during working. As a result of this problem all tubes in the steam generator have been cleaned and re-examined using dye penetrant techniques. Any tubes that had dye penetrant indications were replaced. A total of four confirmed overheated spots or questionable areas were found and all of these tubes have been replaced. Seventeen superheater downcomer tubes were removed from the superheater inlet tube sheet to check the tubes for overheating. The procedure for rewelding these tubes to the tube sheet resulted in poor fusion because of tube mis-alignment. A revised procedure is being developed. Mock-ups will be built to prove out the repair procedure before it is attempted on the actual steam generator. (auth)

30570 (BMwF-FBK-67-35) EIN INDUKTIVER STOSSSTROMGENERATOR FUER HOCHSTROMEXPERIMENTE. (An Inductive Pulse-Generator for High-Current Experiments). Koch, W. (Technische Hochschule, Brunswick (West Germany). Hochspannungsinstitut). Apr. 1967. 12p. (In German). Dep.

The operating principle of an inductive pulse-current generator for plasma physics experiments with high energy is described. The inductances of this generator are charged in series and discharged in parallel into the load. Such an inductive high-current pulse-generator gives the possibility of balancing the limited feeding current and the required load current. An explosion-type switch with a fuse in parallel is used. (auth)

30571 (BMwF-FBK-67-36) BAU UND ERPROBUNG VON GEKAPSELTEN 40 kV-FUNKENSTRECKEN UND KURZSCHLIESSERANORDNUNGEN FUER NIEDERINDUKTIVE KONDENSATORBATTERIEN. (Construction and Testing of Fully Enclosed 40-kV Spark Gaps and Crowbar-Devices for Low Inductive Condenser Banks). Brilka, R. (Technische Hochschule, Brunswick (West Germany). Hochspannungsinstitut). Apr. 1967. 19p. (In German). Dep.

A study dealing with the construction and the testing of pressurized 40 kV-spark gaps for condenser banks in plasma physics experiments is described. A crowbar device, available for 20 kV only up to the present, has been developed. It has a very low inductivity of about 42 nH. In addition the influence of the casing of the spark gaps on the operative characteristics and the reliability of operation have been determined by several tests. (auth)

30572 (CEA-R-3167) OPTIMISATION DES DESCENTES DE COURANT DANS DES ENCEINTES CRYOGENIQUES. (Optimum Input Leads for Cryogenic Apparatus). Der Nigohossian, Gerard (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Feb. 1967. 120p. (In French). Dep. Thesis.

The electrical leads used to introduce a current into a cryostat cause a heat influx due to thermal conduction and to Joule heating. It is important to be able to minimize this flux. Theoretical calculation of optimized leads takes into account the varying heat and electrical conductivities of the leads as well as the heat exchange coefficient with the effluent gas. Practical results are summarized in different tables which permit for a specific material i.e., copper, aluminium, brass, and stainless steel with the intensity and end temperatures being known (i.e., 4.2 or 18.5°K at the cold end and 77,295 or 320°K at the warm end) to deduce the minimum heat flow and the length-cross section ratio of the optimized leads. The solution of the problem using other materials is also presented. (auth)

30573 (CLM-R-71) HIGH CURRENT SWITCHING USING LOW INDUCTANCE FIELD DISTORTION SPARK GAPS CLOSELY CONNECTED IN PARALLEL. Barnes, P. M.; Gruber, J. E.; James, T. E. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). Mar. 1967. 33p. (CONF-660530-12). Dep. CFSTI. UK 4s. 0d.

From 4th Symposium on Engineering Problems in Thermonuclear Research, Frascati, Italy.

The development of 60 kV low inductance (15 nH) pressurized field distortion spark gaps is described, and the influence of electrode arrangement and trigger circuit parameters on breakdown time and jitter has been investigated. The necessary conditions for the satisfactory parallel operation of spark gaps with no transit time isolation between them, has been deduced theoretically. Such a 60 kV capacitor bank with closely connected parallel spark gaps has been operated successfully. The same principles are being used in the design of multiple arc spark gaps. (auth)

30574 (CONF-660904-Vol.1 and 2, pp 656-75) EFFECTS OF PARTICLE ACCUMULATION ON AEROSOL FILTER LIFE. Billings, Charles E. (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials).

Accumulation of deposited material during fiber filtration of solid aerosol particles causes a decrease in filter penetration and

an increase in filter resistance. The operating characteristics of a fibrous filter are shown to be functions of the particle accumulation. Test data are presented for the effects on performance of 1.3-micron polystyrene particles collected in 10-micron glass-fiber filter mats. A list of 23 references are included. (auth)

30575 (CONF-660904–Vol.1 and 2, pp 701-13) PENETRATION OF SUBMICRON T1 BACTERIOPHAGE AEROSOLS AND BACTERIAL AEROSOLS THROUGH COMMERCIAL AIR FILTERS. Harstad, J. Bruce; Decker, Herbert M.; Buchanan, Lee M.; Filler, Melvin E. (Army Biological Center, Frederick, Md.).

A new method is described for evaluating air filters with submicron aerosols. The method is unique in that the aerosols were viable, highly concentrated, and composed entirely of submicron particles. Submicron aerosols were produced from concentrated aqueous suspensions of highly purified Tl bacteriophage. Tests were conducted to compare the effectiveness of several ultra-high-efficiency air filters in removing submicron Tl phage aerosols and bacterial aerosols of Bacillus subtilis var niger spores. The bacterial aerosols were composed mainly of single spores and had a NMD of 1 micron. Submicron aerosol penetration averaged 3×10^{-3}%. Bacterial aerosol penetration averaged 7×10^{-4}%. Architects, engineers, and research investigators concerned with the control of submicron particles might consider filtration rather than other methods of air cleaning. (auth)

30576 (CONF-660904–Vol.1 and 2, pp 763-80) EVALUATION OF TWO PORTABLE THERMAL AEROSOL GENERATORS FOR IN-PLACE FILTER TESTING. Knuth, R. H. (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

Two commercial, portable thermal aerosol generators were evaluated to determine their practicability for in-place testing of high efficiency filters. Penetration values of various high-efficiency filters were determined with the two thermal generators and results were compared with values obtained using standard air-operated aerosol generators of the type developed by the Naval Research Laboratory. It was found that the aerosol produced by the thermal generators was quite stable, and that the particle size distribution was very close to that of the air-operated generators. (auth)

30577 (CONF-660904–Vol.1 and 2, pp 1021-30) TESTING OF AIR CLEANING SYSTEMS: TESTING OF THE COMPONENTS; IN-PLACE TESTS. Billard, F.; Brion, J. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires).

The reliability of air cleaning systems is dependent on the testing they are submitted to. Although in-place tests are the most important as they act as final tests upon achieved plants, component tests are necessary too. They allow detection of defective units before they are installed, partition of unit defects from mounting defects and they are more sensitive. For similar reasons, material tests are most useful. The various tests are described, about aerosol filters for one part, I trap for the other. The checked features are: materials nature, units sizes, efficiency, air resistance, flammability, humidity resistance, temperature resistance, and adsorbent friability. On I trapping systems, small check traps, working in by-pass with the main trap are periodically subjected to efficiency tests. This control allows cutting down the inplace tests frequency, particularly when poisoning from organic vapors is to be feared. (auth)

30578 (CONF-660904–Vol.1 and 2, pp 1032-62) ON-SITE TESTING OF FILTERS WITH SPECIAL REFERENCE TO SOLID AEROSOLS. Flyger, Hans; Rosenbaum, H. C. (Danish Atomic Energy Commission, Risoe, Research Establishment).

A Li flame photometer test is proposed for onsite testing of filter installations. The Li test is intercalibrated with the standard Sodium Flame Test. The spraying time needed to introduce the Li salt into a ventilation system is considered inconvenient for systems handling more than 10^5 m^3/h. For such systems photoelectric particle counters can be used with the dust naturally present in the local atmosphere. Where the dust level is too low, Aitken nuclei can easily be artificially generated in sufficient amounts. The relation between filter evaluation by such particle counting and by Li measurements is established. (auth)

30579 (CONF-660904–Vol.1 and 2, pp 1159-66) PROTECTION OF HEPA FILTER SYSTEMS AGAINST HIGH EXPANSION FOAM PLUGGING. Lindeken, C. L.; Taylor, R. D. (California Univ., Livermore. Lawrence Radiation Lab.).

When high expansion foam is used as a fire control agent in gloved box enclosures exhausted through HEPA filter systems, the foam volume should be controlled to avoid enclosure flooding and foam-plugged filters. Without such control, provisions for foam condensation must be provided between the enclosure and the filter system. Of the techniques we have investigated, centrifugal separation appears to be the most efficient. Up to five box volumes of foam can be condensed with a cyclone separator operated at 35 cfm and an entry velocity of 10,000 fpm. However, the high pressure drop exceeds the capacity of most fans used to ventilate gloved boxes. This problem has been overcome by passing the foam through a squirrel cage fan which is operated at 5,000 rpm and is mounted coaxially in the vertical duct from the box. Foam enters the fan and is impacted against the chamber wall. Coalesced liquid drains back into the box through outer slots in the rotor support. Although this separator has less capacity, the energy for foam condensation is supplied by the fan and no demands are made on the gloved box ventilation system. (auth)

30580 (CONF-661016, pp 3-7) SIMULTANEOUS SWITCHING OF MANY PARALLEL TRIGATRONS WITHOUT DECOUPLING LEADS. Friedrich, F. J.; Hintz, E. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Plasmaphysik).

Up to now it has been standard technique to use transmission lines as decoupling elements between spark gaps operating in parallel. Their electrical length was chosen so as to provide a transit time of at least the jitter time of the switches. This method however provides a sufficient but not necessary criterion for parallel switching. When several spark gaps are used to switch one single capacitor, the capacitance of the connection plate on the input side of the spark gaps must also be considered. These problems are being investigated. Using up to 8 simple trigatrons connected directly to a standard collector as capacitance and to a high inductance load, it has been shown that parallel firing is achieved. Detailed measurements of the influence of important parameters like capicitances of the input and output sides of the spark gaps, load inductance and the operating range of the switches will be presented. (auth)

30581 (CONF-661016, pp 83-94) MANUFACTURING TECHNIQUES USED IN FABRICATION OF HELICAL, SEMI-TOROIDAL ELECTRICAL WINDINGS. Joyce, Jack B. (Princeton Univ., N. J. Plasma Physics Lab.).

A comparison is presented of several methods of manufacture used in the construction of four electrical coils of a general type receiving increasing attention in CTR research. The coil shape in all cases is semitoroidal with conductors forming a helix of appreciable pitch about the toroidal center line. Each of the four coils has unique features arising from operational requirements, materials, manufacturing limitations and cost considerations. (auth)

30582 (CONF-661016, pp 95-102) TURN-TO-TURN VOLTAGE TEST METHODS USED FOR ELECTRICAL INSULATION OF MAGNET COILS. Bushnell, C. W.; Johnson, H. G. (Princeton Univ., N. J. Plasma Physics Lab.).

Two types of turn-to-turn voltage testers used in the testing of electrical insulation between turns of coils and stabilizing windings constructed by the Plasma Physics Laboratory are presented. One tester is a 2.5 kV, high-power gated oscillator adjustable from 5 kHz to 1 MHz, used to drive the coil under test at its self-resonant frequency. The second is a thyratron-controlled impulse tester used for higher voltage tests to 20 kV. Typical test applications to various coils and the interpretation of test results are discussed. A method for locating shorted turns in coils is also described. (auth)

30583 (CONF-661016, pp 103-5) ROLE OF FERROMAGNETIC MATERIALS IN THE DESIGN OF MAGNETIC FIELDS USED IN PLASMA PHYSICS RESEARCH. Wakefield, Kenneth E. (Princeton Univ., N. J. Plasma Physics Lab.).

Relatively simple models are discussed for treating the problem by which one can accurately predict the characteristics of the system. Also discussed are techniques for removing the nonlinearity of some systems. The concepts introduced can be used in analytical studies, in scratch pad, order of magnitude approximations or in more accurate computer calculations. Examples include geometries in which unfavorable effects are minimized and in which desired field properties are obtained. (M.O.W.)

30584 (CONF-661016, pp 153-5) ENGINEERING STUDY OF SPECIAL TERMINATIONS FOR A DELAY-LINE POWER SUPPLY. Huggins, Leroy G.; Pelovitz, Milton (Princeton Univ., N. J. Plasma Physics Lab.).

A delay line is to be used to provide pulsed power for a push–pull amplifier. Initial operation of the system was not satisfactory, as oscillation of the delay line output voltage was experienced, and its rise time was not sufficiently fast. The termination of the delay line was modified to produce the required pulse shape. A description is given. (auth)

30585 (CONF-661016, pp 229-34) PULSED-COIL SYSTEM FOR GUIDING AND INJECTING PLASMA INTO THE GENERAL ATOMIC TOROIDAL OCTOPOLE. Schupp, Arthur A. Jr.;

Ohkawa, Tihiro; Yoshikawa, Masaji (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

The design and operation of a pulsed coil system for guiding and injecting plasma into the center of a minimum-B magnetic field configuration such as the General Atomic toroidal octopole is discussed. Originally plasma was injected through a system of holes or slots in the side of the device with no coil system to correct the field errors produced by this injection port. Plasma entering the device would interact with the strong vertical magnetic field and then spread around the device near the walls. This produced a high density cloud of cold gas near the injection port which limited the containment time to 30 μsec. A coil system was designed, with none of its elements in the containment volume of the octopole device, that eliminated the main magnetic field from the injection port to the octopole axis during the few microseconds while plasma is injected. A major improvement to the above coil system was made by modifying the system so that a longitudinal guiding field could be produced in the coil system and into the injection channel. The coil was designed in such a way that the amplitude of the guiding field and the field producing the channel could be independently varied. The coil system also produced a slowly varying field (approximately 6 msec) which reduced the main field errors created by the injection port opening. With the final coil system the background pressure of the gas produced by the plasma was reduced from an estimated 10^{-4} torr to approximately 5×10^{-6} torr and the containment increased to a point where it was not completely charge exchange limited. (auth)

30586 (CONF-661016, pp 235-46) DESIGN CURVES FOR ELECTROMAGNETIC FIELD DIFFUSION INTO CONDUCTORS UNDER PULSED DISCHARGE CONDITIONS. Medford, R. D.; Griffiths, D. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.).

Design curves are presented, for typical current waveforms showing variations of magnetic field, with time, at various depths and variations of electric field and Poynting vector, with time, at the surface of an infinite half-plane conductor. The boundary waveforms are those given by pulsed currents from switched LCR circuits. These curves may be used only when the current waveform is controlled by lumped L, C, R elements, not when the total resistance is largely determined by the skin effect. They do not apply, except under very restricted conditions, to magnetic materials ($\mu \neq 1$). They can be applied approximately to conductors having curved boundaries provided the penetration depth is sufficiently small. (auth)

30587 (CONF-661016, pp 315-24) FAST RELIABLE FLOATING LIGHT PULSER AND LIGHT TRIGGER. von Voros, Geza; Opat, Henry (Stevens Inst. of Tech., Hoboken, N. J. Dept. of Physics).

High voltage, high energy discharge systems inherently generate rf noise of considerable magnitude. This noise may cause mistriggering of a programmed system as well as it may affect and falsify diagnostic data. The development of a fast light-pulser and light-trigger is introduced to eliminate direct connection between the high energy discharge system and the commanding and programming devices. (auth)

30588 (EURAEC-1787) INVESTIGATIONS ON CYCLONES FOR STEAM SEPARATION IN BOILING WATER REACTORS. Quarterly Report No. 4, October 1-December 31, 1966. Tischer, Vollradt (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main (West Germany). Kernenergieanlagen). Contract 083-66-1 TEED. 72p. (EUR-3329). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

The design geometry of mixture-inflow axially fed steam separators is presented. The arrangement requires steam separators located along several rows in the reactor drop space. The design criteria requires that each cyclone row have equal mass flow and uniform mixture quality. By using various guide inserts to alter flow of mixture influx, it was found that the air flow did not differ by more than ±4%, and the water flow by more than ±6% from the average load from the front and rear cyclone row. After changing from air-water to steam-water mixtures under reactor conditions, even more uniform distribution of mass flow is expected. Therefore, the mixture flow can be satisfactorily controlled with guide plates. (D.C.C.)

30589 (GEAP-5283(Vol.1)) RADIAL VANE STEAM SEPARATOR DEVELOPMENT. VOLUME I. Final Report, Phase I. Moen, R. H.; Kudirka, A. A.; Gifford, J. E. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jan. 1967. Contract AT(04-3)-189. 141p. (EURAEC-1854(Vol.1)). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

The development of a radial vane steam separator to be used for internal mechanical steam separation for direct-cycle boiling water reactors is described. The characteristics of flow on the circular wall of the separator model, flow in the inlet steam-water plenum and in the nozzle, effect of nozzle length on separator performance, and sources and distribution of carryover and carryunder were studied. Models were made and studied at the Steam-Water Test Facility, the Small Air-Water Test Facility and the Large Air-Water Test Facility. Test facilities are described and test results are given. An in-reactor test of the separator is proposed. (F.S.)

30590 (GEAP-5283(Vol.2)) RADIAL VANE STEAM SEPARATOR DEVELOPMENT. VOLUME II. Final Report, Phase I. Moen, R. H.; Kudirka, A. A.; Gifford, J. E. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jan. 1967. Contract AT(04-3)-189. 232p. (EURAEC-1854(Vol.2)). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

Data are presented on the development and testing of radial vane steam separators. Data from tests performed at the Steam-Water Test Facility, Small Air-Water Test Facility and the Large Air-Water Test Facility are included. The data were used in designing a radial vane steam separator for internal mechanical steam separation in boiling water reactors. (F.S.)

30591 (IPP-4/41) ARC BREAKDOWN SOLID DIELECTRIC SWITCH CAPABLE OF MAKING A PARALLEL METAL CONTACT. Bayes, D. V. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Mar. 1967. 17p. Dep.

Establishing a metal contact following an arc contact in a solid dielectric switch is demonstrated. Contact times of about 15 μsec have been measured and it is proposed that times of about 7 μsec will be achieved with a redesigned switch. Measurements of contact resistance and current-carrying capability have not been made. (auth)

30592 (IPP-4/42) DATEN VON POLYAETHYLENISOLIERTEN HOCHSPANNUNGS-KOAXIALKABELN. (Data of Polythene-Insulated High-Tension Coaxial Cable). Baeumler, J. G. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Apr. 1967. 20p. (In German). Dep.

The dielectric strength and the other most common electric data of the types of high-voltage cable most frequently used at the IPP are measured for dc and ac, 50 cps. The physical size is also determined. (auth)

30593 (JAERI-1130) EXPERIMENTAL AND THEORETICAL STUDIES OF THE EXPANSION JOINTS (BELLOWS) IN THE PIPING SYSTEMS OF NUCLEAR REACTORS. Miyazono, Shohachiro (Japan Atomic Energy Research Inst., Tokyo). Nov. 1966. 35p. (In Japanese and English). Dep.

In the piping systems of various nuclear power plants, U-shaped expansion joints are employed to absorb the vibration, expansion, and tension which are caused by thermal or mechanical loads. The theoretical and experimental results which were acquired on some expansion joints when a mechanical load is applied to them are described. A theoretical analysis of a U-shaped expansion joint was made by separating into three parts, namely an annular plate, inner and outer toroidal shell of circular cross section. The basic equations for bending and normal force are used for each part and the solutions are worked out in the form which satisfies the conditions of compatibility and continuity in two boundaries. The theoretical and experimental results for some expansion joints which are generally employed in the piping systems of nuclear and chemical plants are compared. In the experiment, strains were measured with strain gages. The results agree with the accuracy of about 10%. (auth)

30594 (LA-DC-8731) IMPROVED TEE CONNECTIONS FOR VACUUM-JACKETED TRANSFER LINES. Ruess, Hermann M. (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 12p. (CONF-670801-3). Dep. CFSTI.

For presentation at Cryogenic Engineering Conference, Palo Alto, Calif.

A process was developed to form the outer and inner tees in vacuum-jacketed transfer lines at any desired location during assembly. In order to use commercial tee components for the inner jacket, the inner diameter of the outer jacket must be larger than the height of the tee component. Tee connections are made by drawing a die of circular cross section through an elliptical cutout in the wall of the outer jacket. The tee is formed in the inner jacket in the same way, with the inner jacket inside the outer jacket. The shape of the cutout is such that the end of the tee is a flat surface requiring only minor weld preparation. The ends of both tees are fusion welded to extension tubes. The weld geometry simplifies welding procedures, a smooth transition from the main tube

to the side tube is produced, and the vacuum space can be reduced to 1/8 in. Fabrication to single-system, mass production, or field applications is economic. (auth)

30595 (ORO-2430-40) SUPERCONDUCTING CIRCUITRY. Progress Report. Vail, Charles R. (Duke Univ., Durham, N. C. Dept. of Electrical Engineering). June 1967. Contract AT(40-1)-2430. 27p. Dep. CFSTI.

In the development of optimum materials for thin film devices for use in computer circuitry, surface, magnetic, dielectric, and strain effects; deposition techniques; and properties of films detached from substrates were studied. The conductivity surface characteristics, and electric properties of thin gold films were determined. Grain and surface structure data for nickel films deposited by electron bombardment on glass substrate were evaluated. Nickel and permalloy pure films were deposited by evaporation. X-ray diffraction was used to study strain distribution in thin gold films. Capacitors using a bismuth oxide insulating layer with thin gold films evaporated on them are discussed. (F.S.)

30596 (TID-4100(Suppl.39)) SUPPLEMENTAL INSERT SHEETS FOR ENGINEERING MATERIALS LIST. Kelly, Robert C. (ed.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). June 1967. 56p. Dep. DTIE Free.

Thirty packages of engineering materials on accelerators, electronic equipment, metallurgical equipment, radiation detectors, reactor equipment, and vacuum equipment are announced in this supplement for inclusion in TID-4100. (F.S.)

30597 (WAPD-T-1892) PROPOSED REINFORCEMENT DESIGN PROCEDURE FOR RADIAL NOZZLES IN SPHERICAL SHELLS WITH INTERNAL PRESSURE. Cloud, R. L.; Rodabaugh, E. C. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Dec. 1965. Contracts AT(11-1)-Gen-14; NObs 90029. 59p. Dep. CFSTI.

A procedure for reinforcement of nozzles in hemispherical heads is presented. The procedure is intended to ensure the nozzle will not plastically collapse and will "shake-down" to elastic action. The procedure is explained at length and compared to other design procedures. (auth)

30598 (ORNL-tr-1614) CONCRETE AS A PROTECTION AGAINST RADIATION. Vinkeloe, R. Translated for Oak Ridge National Lab., Tenn., from Betonstein Ztg., 30: 642-6 (1964). 16p. Dep. CFSTI.

Concrete is suited for the shielding of gamma rays as well as neutrons. By the choice of suitable aggregates the bulk density of concrete can be varied within wide limits; in addition, its hydrogen content can be varied. Its absorptive capacity for thermal neutrons can be considerably increased by the admixture of small quantities of boron compounds. Concrete is given its shape and form on the construction site. It can be economically adapted to practically any desired and required constructional shape. Besides radiation shielding, it can also perform load-bearing and space-enclosing functions. The general conditions for radiation shielding, with special reference to considerations of concrete technology, and the efficient composition of the protective concrete are presented. (auth)

30599 (RFP-Trans-26) INSTALLATION OF A METTLER THERMOANALYZER IN A GLOVE BOX. Seiffert, H. Translated from Internal Report, IRCH Transuranics 1/66. 26p. Dep. CFSTI. JCL $2.60 fs, $0.98 mf.

A description of the installation of a Mettler Thermoanalyzer in an alpha glove box is presented. The necessary rebuilding work on the instrument, the construction and the installation of the box as well as the performance and the heat-removal by means of a high temperature oven is described. Wiring diagrams and the function of the components are also presented. (auth)

30600 OPTIMUM THICKNESS TRANSITIONS FOR CYLINDRICAL PRESSURE VESSELS WITH HEMISPHERICAL HEADS. Tsui, E. Y. W.; Burns, A. Bruce (Lockheed Palo Alto Research Lab., Calif.). J. Spacecraft Rockets, 4: 716-19(June 1967).

An analysis is presented for two new thickness transition configurations for cylindrical pressure vessels with hemispherical heads. These configurations, which extend on both sides of the juncture between the shells, are the versine variation and the bilinear variation. The bilinear transition is shown to result in lighter designs while holding overstress to a negligible amount. Nondimensional curves are presented which show the over-all vessel weight for both types of transition. Results are obtained by solving numerically a system of second-order differential equations applicable to thin elastic isotropic shells of variable thickness, using an estimated decoupling criterion for spherical and cylindrical shells under edge loads. (auth)

30601 HIGH-TEMPERATURE TESTING AND EVALUATION OF GRAPHITE HELICAL-SCREW EXPANDERS AND COMPRESSORS. Wells, W. M.; Hanner, D. W.; McElroy, J. L.; Robinson, E. (Univ. of California, Livermore). J. Spacecraft Rockets, 4: 761-7(June 1967).

A graphite expander, utilizing intermeshing helical rotors and following concepts of Lysholm, was demonstrated for possible use with inert gas cycles. Two demonstration assemblies were tested. Each assembly consisted of a graphite expander and an identical compressor. They were operated in an argon atmosphere where the motor-driven compressor provided pressurized argon to drive the expander. The graphite-on-graphite sliding bearings used were adequate for demonstration but probably not for application. Work is under way on graphite roller and gas bearings. In the first assembly the compressor failed catastrophically because of rotor dragging. The second assembly ran for 274 hr at furnace temperatures between 2350° and 2730°F before voluntary shutdown. Expander inlet temperatures are estimated to have exceeded 2900°F. Speeds to 14,100 rpm in the compressor and efficiencies to 37% in the expander were achieved. Shaft power to the compressor exceeded 10 hp and from the expander approached 1 hp. Pressure ratios in excess of 1.5 were achieved. A more detailed account of the tests may be found in the AEC report UCRL-14660 (January 1966). (R.E.U.)

30602 CHARACTERISTICS OF A NEW HIGH-VACUUM STOPCOCK. DeZeeuw, R. G.; Boultinghouse, K. D. (Sandia Lab., Albuquerque, N. Mex.). J. Vac. Sci. Technol., 4: 134-5(May-June 1967).

A special greaseless, nonmetallic, high-vacuum stopcock is described which ensures low contamination of chemical preparations. (D.E.B.)

30603 ALL-METAL INDIUM VALVE SEAT FOR LARGE-DIAMETER IN-LINE GATE VALVES. Welch, K. (Stanford Univ., Calif.). J. Vac. Sci. Technol., 4: 135-7(May-June 1967). (SLAC-PUB-206).

The principle of hydraulically confining a soft metal was employed in developing a low-leakage valve seat. An indium seat material confined by stainless steel produced a valve seat with helium leak rates of 10^{-8} cc/sec for a sealing force of 400 lb/in. (D.E.B.)

30604 IMPROVEMENTS IN OR RELATING TO GRINDING DEVICES. Van Lierde, Walter (to European Atomic Energy Community (EURATOM)). British Patent 1,072,190. June 14, 1967. Filed Dec. 1, 1964.

The design of a precision grinding machine is given. It is capable of grinding and polishing small samples in order to produce a nearly optically flat surface. (J.C.W.)

30605 INDUCTION HEATER FOR A SODIUM CIRCUIT. Fielder, E. A.; Davidson, D. F. (United Kingdom Atomic Energy Authority, Risley, Eng.). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-85/17, 10p. (CONF-661110-22). DTIE.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna.

The Fuel Element Thermal Test Loop at the Reactor Engineering Laboratory of the United Kingdom Atomic Energy Authority makes use of proven pumps of the electromagnetic linear induction type which are limited to a sodium temperature of 375°C. The sodium test section flow of 350 gpm is raised to 650°C by a 10-MW heat recuperator and a 400-kW electrical heater which replaces the circuit losses. Experience showed that the use of sheathed mineral-insulated heaters was unsatisfactory for this heater, and an alternative method using mains frequency (50 cps) induction was adopted. The heater is in the form of a power transformer, the secondary winding of which is a single short circuited turn formed by a stainless steel pipe loop containing the sodium. With suitable lagging and cooling arrangements the iron core and primary windings are maintained at temperatures low enough for normal electrical insulating materials to be used. Conventional methods for the fabrication of the pipe loop circuits are also possible. The design construction and operation of the induction heater are described. The design balance between the differing requirements of electrical efficiency, hydraulic pressure drop and the geometry imposed by the space available in the rig is discussed. Suggestions for improvement of these factors at the expense of others are given. The performance of the heater is given and compared with the predicted performance. (auth)

30606 CENTRIFUGAL EXTRACTOR. Webster, D. S.; Winsche, W. E. (to U. S. Atomic Energy Commission). U. S. Patent 3,332,614. July 25, 1967.

A centrifugal liquid-liquid extractor is described. Process liquids are fed into one end of the cylindrical centrifuge bowl and extracted from the other end of the bowl after having been separated into light and heavy fractions by a weir section. The weir section is made up of a number of spaced flat circular plates

which extend generally perpendicular to the rotational axis of the bowl. The first of these plates has both central and peripheral openings for respective passage of light and heavy phase liquids, the light phase liquid being removed from the bowl by a duct positioned to communicate with the central openings. A second plate has a central opening which functions as a heavy phase weir. A third plate has a peripheral opening at a radius greater than the central opening of the second plate; the first and third plates define a heavy phase weir chamber. The heavy phase outlet is beyond the third plate and means positioned between the third plate and the heavy phase outlet cooperate with the third plate to seal pressurized gas introduced from an external source in the weir chamber in order to control the crest of the liquid flowing over the heavy phase weir. (AEC)

Heat Transfer and Fluid Flow

Refer also to abstract 30572.

30607 (AE–276) BURNOUT CORRELATION FOR FLOW OF BOILING WATER IN VERTICAL ROD BUNDLES. Becker, Kurt M. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Apr. 1967. 103p. Dep.

A rod bundle burnout correlation was developed from a previous rod bundle correlation for low pressures. The correlation shows that the burnout conditions in wide ranges of variables are independent of the inlet sub-cooling and the heated length, and that the effects of mass velocity and pressure are the same in rod bundles and in round tubes. It is also demonstrated that the effects of a radial heat flux variation within the rod bundle can be handled by the correlation by modifying the η-value for the bundle. The rod bundle data presented by Janssen and Kervinen, Hench, Obertelli, Matzner, Haslam, Edwards and Obertelli and Hench and Boehm were also analyzed in terms of the measured and predicted burnout heat fluxes. These data covered bundles consisting of 3, 4, 6, 7, 9, 19 and 36 rods and it was found that a very good agreement existed between the present correlation and the measurements. (auth)

30608 (ANL–7296) HEAT TRANSFER FROM A SPHERE TO LIQUID SODIUM DURING FORCED CONVECTION. Witte, Larry C. (Argonne National Lab., Ill.). Jan. 1967. Contract W-31-109-eng-38. 99p. Dep. CFSTI.

Thesis. Submitted to Oklahoma State Univ., Stillwater.

Heat transfer rates from ½-in.-dia tantalum spheres to liquid sodium were measured as the spheres moved through a sodium pool. The experimental data were obtained by a transient technique. These experimentally obtained heat transfer rates are compared to theoretically obtained heat transfer rates. By assuming that no vapor is formed at the sphere surface and that superheating of liquid sodium near the surface may occur, a theory is developed to show that large amounts of subcooling in the liquid and motion of the sphere prevent the formation of vapor at the surface of high-temperature spheres. The film-boiling theory which predicts extremely thin vapor films is also developed. The experimental data are correlated with sphere velocity and bulk sodium temperature. (auth)

30609 (CONF-660904–Vol.1 and 2, pp 647-55) MECHANICS OF COLLECTION OF PARTICLES BY INERTIA AND INTERCEPTION IN A FIBROUS AIR FILTER. Dawson, Stanley V. (Harvard School of Public Health, Boston, Mass.).

An approximate expression is developed for the efficiency of collection of particles by small inertia force and by direct interception from an air stream around a circular cylinder. The field used to describe the fluid flow is in agreement with Darcy's Law for pressure drop through an array of cylinders. Efficiency is calculated by locating the grazing trajectory of a spherical particle. This location is determined by manipulating the equations of motion to facilitate an analytic approximation valid for small values of the impaction and interception parameters. Comparison of the predicted efficiency with values given in one experimental report proved inconclusive in assessing the validity of the prediction. (auth)

30610 (EUR–3459.e) BASIC RELATIONSHIPS IN n-COMPONENT DIABATIC FLOW. Wundt, H. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Apr. 1967. 80p. Dep.

Relationships between the extensive quantities mass, volume, total energy, and momentum, and their related specific quantities, their densities, as well as their density currents, are compiled. On the basis of the "complete-mixing model" (the constituents may have different velocities, but fill each one the whole volume) and the conception of partial quantities, equivalent relationships are derived also for n-component flowing mixtures. With the aid of these expressions the general balances for mass, partial masses, momentum and energy (subdivided into internal, displacement, kinetic and potential energies) are established in three-dimensional, time-dependent coordinate-free partial differential equation notation. Specialization to one-dimensional two phase flow is made. The "complete-mixing model" is the only field theory that permits to avoid the consideration of chaotically numerous and transient internal boundary conditions at bubbles and droplets during boiling. Its drawback is that slip effects, inter-phase viscosity, pressure drop, heat conduction, and the magnitude of the heat transfer coefficient for various flow-patterns cannot properly be seized. It is proposed to combine some simplified equations with the necessary empirical correlation knowledges. The momentum equation proves to be unable for inclusion in a computer programme because of insufficient determination of the stress tensor for two phase flow. Details of the energy equation suffer equally from this difficulty so that, up to now, only its roughest statements could be applied. A set of two equations is given and repeated in the conclusions which may be useful for calculating transients in heat exchangers and around boiling water reactor fuel elements, stability problems being excluded. (auth)

30611 (GEAP–5423) FILM BOILING HEAT TRANSFER MEASUREMENTS IN A TUBULAR TEST SECTION. Mueller, R. E. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jan. 1967. Contract AT(04-3)-189. 35p. (EURAEC–1871). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

A tabular geometry was used in tests to obtain heat transfer data for fully-developed film boiling at a pressure of 1000 psia with mass velocity of 0.50 and 0.75 M lb/h-ft^2. Fully-developed film boiling coefficients were measured along with steam phase temperatures using a special temperature probe. The probe data demonstrated quantitatively that the steam phase was superheated for heat transfer from a dry wall to a flowing steam-water mixture. (auth)

30612 (IDO–17226) A REVIEW AND DISCUSSION OF LITERATURE CONCERNING TRANSIENT HEAT TRANSFER AND STEAM FORMATION. Morgan, Robert P. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Mar. 1967. Contract AT(10-1)-205. 70p. Dep. CFSTI.

A review of experimental and theoretical information relevant to the prediction of forced-convection coolant behavior in subcooled water-reactor transients is presented. Emphasis is placed upon the determination of transient subcooled void fractions and the description of transient heat transfer from fuel element surfaces to the coolant under both boiling and nonboiling situations. A number of recommendations for improving existing reactor-transient computer programs are made. Among these are a quasi-steady method for predicting the fraction of the surface heat flux which is utilized in void volume production in the slightly subcooled nucleate boiling region and a semiempirical equation for predicting transient void fractions. In general, it has been concluded that a complete and reliable analytical description of reactor coolant transient behavior is not presently possible, primarily because of uncertainties concerning the validity of quasi-steady methods during rapid transients and because of a lack of fundamental knowledge at the point of departure from nucleate boiling and beyond. Detailed analysis of recent in-pile and out-of-pile transient data, however, should lead to a better understanding of coolant behavior during subcooled transients. (auth)

30613 (LA–3616) EFFECT OF SELF-INDUCED THERMAL-ACOUSTIC OSCILLATIONS ON HEAT TRANSFER TO HYDROGEN. Thurston, Rodney S. (Los Alamos Scientific Lab., N. Mex.). Dec. 1966. Contract W-7405-eng-36. 36p. Dep. CFSTI.

The effect of self-induced thermal-acoustic oscillations on heat transfer to hydrogen in a 0.25-in. ID by 10-ft-long electrically heated stainless steel tube was studied. Pressures were varied from a subcritical 112 psia to a supercritical 265 psia. Two acoustic modes were observed. One, the first harmonic of standing waves in a pipe open at both ends, occurred at frequencies between 70 and 150 cps and was recorded only for pressure. The second was Helmholtz resonance, which is the acoustic analogy to a spring-mass system. Helmholtz oscillations were observed between 4 and 34 cps on records of pressure, temperature, and flow rate. The maximum Helmholtz-mode pressure amplitude was 34 psi peak to peak, and the maximum fluid temperature amplitude was 100°R peak to peak. Heat transfer to gaseous hydrogen was not affected by axially oriented Helmholtz-mode oscillations with long wavelengths relative to the length of the test section. Heat transfer to two-phase and supercritical hydrogen was influenced by the generation of thermal-acoustic oscillations. Heat transfer improved as the inception of oscillations was approached,

but once oscillations occurred, increasing the intensity did not improve the transfer. (auth)

30614 (LA-3714) ORBITAL HEAT PIPE EXPERIMENT. Deverall, J. E.; Salmi, E. W.; Knapp, R. J. (Los Alamos Scientific Lab., N. Mex.). June 5, 1967. Contract W-7405-eng-36. 14p. Dep. CFSTI.

Includes Appendix by G. F. Erickson.

The "Grover Heat Pipe" is a self-contained, thermal conductance device which has no moving parts, utilizes the heat being transferred for its operation, has a thermal conductance higher than any known material, and conducts heat with essentially no temperature difference. Heat is transferred by means of mass flow of a fluid utilizing the latent heat of a two-phase system. The proper functioning of a heat pipe in a zero gravity field is described. A water heat pipe, 12-in. long and $\frac{3}{4}$-in. OD, was operated in an earth orbit and its performance monitored by telemetry at several tracking stations during 14 revolutions. Results indicate that there was no degradation of heat pipe performance in a zero gravity field as compared to the performance in laboratory tests. (auth)

30615 (LA-DC-8726) OSCILLATIONS IN FLOWING AND HEATED SUBCRITICAL HYDROGEN. Rogers, John D. (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 22p. (CONF-670801-2). Dep. CFSTI.

For presentation at Cryogenic Engineering Conference, Palo Alto, Calif.

A hydrogen system in the lower, subcritical pressure range was studied to observe the threshold for transition from stable to unstable flow with heat addition. Sensitive temperature and pressure detectors and photographic observation provided data which can be readily correlated in terms of recent density variation theory. Steady oscillations in the unstable state are associated with the onset of vapor formation and at high heat rates with large pressure oscillations are characterized by vapor nucleation delays or subcooling just prior to the vapor formation and by bubble collapse rates. (auth)

30616 (NAA-SR-12355) THERMAL BEHAVIOR OF SNAP 8 REACTOR DURING ATMOSPHERIC REENTRY. Montgomery, L. D.; Arnold, J. E.; Mouradian, E. M.; Nelson, D. K. (Atomics International, Canoga Park, Calif.). May 1, 1967. Contract AT(04-3)-701. 66p. Dep. CFSTI.

An analysis was made to simulate the thermal behavior of a SNAP-8 type reactor system during reentry into the earth's atmosphere. The objective was to determine whether sufficient ablation will occur to release the reactor core at an altitude that will ensure complete burnup of the fuel elements in the upper atmosphere. Results show that the SNAP-8 reactor vessel will not ablate to a sufficient extent, for probable modes of reentry, to release the fuel elements at altitudes necessary to obtain complete fuel ablation. (auth)

30617 (NAA-SR-12383) SNAP 8 CONFIGURATION REENTRY HYPERSONIC HEATING RATES DERIVED FROM A SHOCK TUNNEL TEST. Nelson, D. K. (Atomics International, Canoga Park, Calif.). May 1, 1967. Contract AT(04-3)-701. 30p. Dep. CFSTI.

Reentry aerodynamic heating distributions for the SNAP 8 configuration have been obtained based on hypersonic shock tunnel experiments. The heat-transfer correlations are given as a function of angle of attack from 0 to 70 degrees. The perturbative effect of piping on the flow field, and consequently the heat-transfer distributions, was also investigated at the 30- and 60-degree angle-of-attack positions. Test objectives and the criteria upon which the experimental work was based are given along with a description of the Cornell 48-in. Hypersonic Shock Tunnel, test model, and heat-transfer instrumentation. The heat-transfer data have been normalized by the stagnation point value of a hemisphere with the reactor vessel radius. This heat-transfer rate (29.05 Btu/ft^2-sec) was obtained experimentally in the shock tunnel and verified by theory. In addition to the data point values of the sensors in tabular form, schematics of the heat-transfer rates on the reactor-piping complex are given for cases where flow emanates from 0, 30, and 60 degrees from the SNAP 8 system centerline. Aerodynamic heat-transfer rates are shown as functions of angle of attack for locations on the system piping, vessel head, and reactor vessel. (auth)

30618 (ORNL-P-3083) INCIPIENT AND STABLE BOILING SUPERHEAT FOR POTASSIUM BOILING ON A SURFACE CONTAINING REENTRANT CAVITIES. Edwards, J. A.; Hoffman, H. W. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 12p. (CONF-670909-1). Dep. CFSTI.

From Semi-International Symposium of Mechanical Engineers, Tokyo, Japan.

The experimental aspects of heat transfer with boiling potassium on a stainless steel surface containing reentrant cavities are presented. The dependence of superheat on heat flux for both the stable boiling and bubble nucleation modes is also shown. The experimental results show: the reentrant cavities reduce the stable boiling superheat needed to boil potassium; incipient boiling is more apt to occur at small vapor pressures; incipient boiling superheat does not show any definite dependence on heat flux; and the magnitude of the stable boiling superheat is related to cavity size and heat flux. (D.C.C.)

30619 (SC-RR-67-19) FUEL ROD TRANSIENT HEAT TRANSFER: EXPERIMENTS AND ANALYSIS. Rivard, Joseph B.; Mattson, Roger J. (Sandia Corp., Albuquerque, N. Mex.). June 1967. 16p. Dep. CFSTI.

The transient heat transfer and thermal-hydrodynamics of pool-type pulse reactors are considered. Experimental investigation of the transient thermal behavior of pulsed fuel elements, cooled by natural convection, is reported. A preliminary description of a thermal-hydraulic model is given in which two distinct transient heat transfer modes are identified. (auth)

30620 (TID-23809) A STUDY OF THE OPERATING CHARACTERISTICS OF THE HEAT PIPE. Quarterly Progress Report No. 6. Ferrell, J. K.; Carnesale, A. (North Carolina State Univ., Raleigh). Feb. 1, 1967. Contract AT(40-1)-3411. 30p. Dep. CFSTI.

The operating characteristics of a stainless steel heat pipe are described along with an analytical model for predicting operating limits of capillarity-limited heat pipes. A continued analysis of a transient capillary rise model was performed along with comparisons with experimental data. Analysis of basic capillarity phenomena was continued, including determination of meniscus shapes under various conditions. (D.C.C.)

30621 (UCID-15130) SUMMARY REPORT ON THE "LONG JOHN" THERMO-GASDYNAMIC RESEARCH PROJECT. Pitts, J. H.; Van Sant, J. H. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 11, 1967. Contract W-7405-eng-48. 24p. Dep. CFSTI.

Accomplishments of a 5-year-long thermo-gasdynamic research program have included the construction of a unique working experimental facility, development of test-section manufacturing procedures and necessary data-reduction techniques, and experimental operation during which more than 90 adiabatic flow tests were performed. The experimental facility was designed so that highly accurate data could be obtained with flow channels of various lengths and shapes over a large range of pressures, temperatures, and flow rates. The program permitted the development of several data-reduction techniques and verification of the Karman-Nikuradse correlation of adiabatic friction factor (developed with water) for air at high Reynolds numbers. (auth)

30622 (BNL-tr-144) RECENT DATA ON HEAT TRANSFER IN A TURBULENT FLOW OF LIQUID DROPS IN ROUND TUBES. Subbotin, V. I.; Papovyants, A. K. Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from paper presented at the IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna, Austria, November 29-December 2, 1966. 22p. (CONF-661110-35). Dep. CFSTI. JCL $2.60 fs, $0.86 mf.

Various methods for calculation of heat transfer coefficients are presented based on recent data concerning turbulent flow of liquid drops and gases in round tubes. Various values of Nusselt numbers for different Reynolds and Prandtl numbers are compared from the methods of Petukhov and Popov, Osmatchkin, Sparrow, Deissler, and Buleev. The Reynolds and Prandtl numbers are also compared with the length of hydraulic stability for distilled water and oil and stainless steel and nickel using the methods of Allen and Eckert, Malina and Sparrow, and Dipprey and Sabersky. (D.C.C.)

30623 STUDIES ON BURNOUT. PART I. ALTERNATIVE FORMS FOR SOME BURNOUT CORRELATIONS. Clerici, G. C. (ARS SpA, Milan, Univ., Milan); Garribba, S.; Sala, R.; Tozzi, A. Energ. Nucl. (Milan), 14: 280-8(May 1967).

Alternative forms for some burnout correlations can be reduced to the linear form $\Phi_0 = a\,(b - X_0)$, by means of suitable transformations or approximations. The expressions obtained in this way have considerable similarity in the dependence of a and b on the physical and geometrical parameters. Graphical comparisons, given for a particular case, show good agreement among the alternative forms and the original ones. (auth)

30624 IMPROVED DESIGN PREDICTIONS THROUGH LIQUID-METAL HEAT-TRANSFER RESEARCH. Stein, Ralph P. Power Reactor Technol., 9: 174-9(Fall 1966).

Improved methods for predicting surface temperatures in reactor coolant channels and heat-transfer rates in heat exchangers are presented. Three examples of analytical investigations of

liquid-metal forced-convection heat transfer are: fuel-coolant channels as annular spaces with unequal heat fluxes on opposite sides; improvements to account for the effect of nonuniform axial heat-flux distributions; and improvements of heat-transfer rates in liquid-metal-to-liquid-metal heat exchangers. The discussion of errors encountered with each model is presented. (D.C.C.)

Isotope Technology

Refer also to abstracts 30567 and 30807.

30625 (AECL-2666) ELECTROSPRAYING DEVICE FOR PRODUCING THIN, UNIFORM SOURCES FROM ROD DISSOLVER AND FINAL PRODUCT PLUTONIUM SOLUTIONS. Lindsay, S. A. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Apr. 1967. 16p. Dep. CFSTI. CAN $0.50.

Alpha sources, deposited as thin uniform films, can be produced by the ejection of a solution containing the active material from a modified hypodermic needle, while applying an electric field. An apparatus for carrying out the process is described and the results obtained with several different solvents are given. (auth)

30626 (ALO-3634-5) QUARTERLY PROGRESS REPORT OF RESEARCH AND DEVELOPMENT OF VACUUM FOIL-TYPE INSULATION FOR RADIOISOTOPE POWER SYSTEMS, FEBRUARY-APRIL 1967. Dunlay, J. B.; Fronduto, J.; Paquin, M. L.; Poirier, V. L. (Thermo Electron Engineering Corp., Waltham, Mass.). May 31, 1967. Contract AT(30-1)-3634. 42p. Dep. CFSTI.

Progress is reported on the development of high-temperature thermal insulation for radioisotope power systems. The following were investigated: planar heat transfer test results for spray-coated Mo-ThO_2 insulation samples; cylindrical heat transfer test results for W-ThO_2 and Ta-ThO_2 insulation samples; life-test results on the thermal and outgassing characteristics of insulation samples after 1000 hours at 1700°C and 1900°C. (auth)

30627 (DP-1105-1) SAVANNAH RIVER LABORATORY ISOTOPIC POWER AND HEAT SOURCES. PART I. ^{60}Co. Quarterly Progress Report, January-March 1967. Hilborn, H. S. (comp.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). May 1967. Contract AT(07-2)-1. 19p. Dep. CFSTI.

About 9 million curies of ^{60}Co (140 kilowatts) at an average of 400 curies per gram of metal (55 watts/cm^3) will be discharged from the reactor during the next quarter. 5000- and 10,000-hour heating tests of capsules of radioactive cobalt metal contained in "Inconel" 600 were begun at 850°C in air. An "Inconel" 600 capsule with a 0.050-inch-thick wall that reached a temperature of 1100°C for 3 to 6 hours swelled but did not leak. (auth)

30628 (MLM-1390) STABLE GASEOUS ISOTOPE SEPARATION AND PURIFICATION: OCTOBER-DECEMBER 1966. (Mound Lab., Miamisburg, Ohio). Dec. 31, 1966. Contract AT(33-1)-Gen-53. 30p. Dep. CFSTI.

About 0.03 liter/day of 8% ^{21}Ne was withdrawn from the side port of a 4-column, four-stage, neon cascade system. The total neon in the ^{22}Ne product stream increased to 99% after recycle from the 3-column tube bundle was discontinued. Until 8% ^{21}Ne feed was no longer available for the 3-column tube bundle, 0.01 liter/day of over 25% ^{21}Ne was separated. The system was then used to enrich natural abundance neon to 5% ^{21}Ne while a sufficient inventory of 5% ^{21}Ne feed from the 4-column cascade was being accumulated. The location of the ^{21}Ne peak was sensitive to the relative amounts of ^{20}Ne and ^{22}Ne in the feed. The throughput could be increased considerably without significantly changing the effluent concentrations. Three passes were sufficient to enrich ^{21}Ne from 5 to 50%. From a series of xenon-krypton separations on a chromatographic column of 20-cm^2 cross section and packed with molecular sieve 13X, the optimum carrier gas flow was determined to be 9 to 17 liters/min. An argon-krypton separation was made at a column temperature of 87.3°K. This separation was made on a molecular sieve 13X packed column with a 4-cm^2 cross section. Feed loads of 500 ml were run with a 96% recovery of the krypton. The product was 99.95% krypton. ^{124}Xe enriched to 1, 5, and 10% was withdrawn from an eight-stage, xenon, thermal diffusion tube bundle cascade. The 1% ^{124}Xe was withdrawn for a high concentration of ^{129}Xe (~60%). The second pass was started on an 8-column, eight-stage, thermal diffusion cascade. With a feed of 81.5% ^{136}Xe, partial equilibrium enriched ^{136}Xe to 94.6%. A computer program was written to calculate the first, second, and third Chapman-Enskog approximations to the thermal diffusion factor. Comparison of experimental and theoretical results for the neon-xenon system are reported for 55, 100, 200, and 300°C. Calculations were made using the Lennard-Jones and modified Buckingham potential functions. A set of parameters for xenon, recently suggested by W. W. Watson, was tested and proved superior to previous parameters. An extensive series of experiments to determine experimental values of thermal-diffusion column transport coefficients for $^{20}Ne-^{22}Ne$ separation was completed. Column transport coefficients were calculated for krypton from experimental static and flow separation data. Results for different pairs of the six isotopes were in good agreement with theoretical values based on the Lennard-Jones and on the modified Buckingham potentials. (auth)

30629 (MMM-3691-6) SNAP-21 PROGRAM, PHASE II. DEEP SEA RADIOISOTOPE-FUELED THERMOELECTRIC GENERATOR POWER SUPPLY SYSTEM. Quarterly Report No. 1, June 20, 1966-September 30, 1966. Wickenberg, R. (Minnesota Mining and Mfg. Co., St. Paul. Isotope Power Lab.). Oct. 21, 1966. Contract AT(30-1)-3691. 129p. Dep. CFSTI.

Progress is reported on the deep sea ^{90}Sr fueled thermoelectric generator (SNAP-21) power supply system. In the design, development, and fabrication of a thermal insulation system, the neck tube and structural support member for the biological shield were designed and analyzed. Design effort was initiated on the overall 10 W system and components. Tests on thermal insulation inner liner, biological shield, and shield to liner bolts are reported. Conceptual design of the 20 W system was also initiated. A biological shield used previously was refurbished. A copper flame spray process was developed for the inner liner. Additional performance data for the 721 Ti alloy used in the pressure vessel were obtained. (F.S.)

30630 (MMM-3691-17) SNAP-21 PROGRAM, PHASE II. DEEP SEA RADIOISOTOPE-FUELED THERMOELECTRIC GENERATOR POWER SUPPLY SYSTEM. Quarterly Report No. 3, January 1, 1967-March 31, 1967. Weinig, J. F. X. (Minnesota Mining and Mfg. Co., St. Paul. Isotope Power Lab.). May 1967. Contract AT(30-1)-3691. 142p. Dep. CFSTI.

The SNAP-21 system design and trade-off study to investigate possible means of improving system performance is described. Other significant accomplishments discussed include: fuel capsule weld development; ultrasonic weld testing; biological shield plug design; wrapping of the SNAP-21 residual phase I insulation system; and the selection of three tension tie rods and a neck tube as the biological shield support system. Insulation system offgassing tests and vacuum sealoff and getter retention tests were continued. The segmented retaining ring design was analyzed and a design change prepared. Seven pressure vessel materials were examined, and a material (Ti 621.8) was selected. The design for the second three development generators (in-line concept) was initiated. Generator test equipment design parameters were established. Cold and heat transfer tests 4 through 15 were completed. Thermoelectric leg inspection testing was initiated. Radiation testing arrangements of the SNAP-21 biological shield in the insulation system were completed. (D.C.C.)

30631 (N-66-26821) HOT CELL RADIATION TESTING AND INSPECTION. (Lockheed-Georgia Co., Dawsonville). [1965]. Contract NAS8-5332. 28p. (NASA-CR-75302). CFSTI.

Hot cell inspection and testing which was conducted to assure that the radiation shielding requirements were met in the construction of a hot cell complex is described. This was accomplished by measuring the amount of radiation leakage external to the cells from cobalt-60 radiation sources placed within the cells. (STAR)

30632 (ORNL-4107) ELECTROMAGNETIC SEPARATION AND CHEMICAL REFINEMENT OF LEAD ISOTOPES, SERIES LU. Jordan, L. L.; Kinnane, J. A.; Sheridan, C. W.; Tracy, J. G.; Love, L. O. (Oak Ridge National Lab., Tenn.). July 1967. Contract W-7405-eng-26. 25p. Dep. CFSTI.

Lead isotopes were separated and refined to provide an isotopic purity of >73% for ^{204}Pb and >92% for ^{207}Pb. The average total ion output reaching the collector during the series was 21.0 ma and the percent of innage, 89.4. Best results were achieved by the use of a standard $PbCl_2$-charged M-18 ion source unit utilizing a ⅛- × 4-in. ion exit slit, an ion collector with a probe pocket, and a liner with a +10° to −4° ion-exit-angle baffle in the 90° position with additional side shields ahead of the 90° position. Operating procedures were developed to compensate for several characteristics associated with the enrichment of lead in the calutron. These characteristics included defocusing of the ion beam, slowly deteriorating focus and subsequent decrease in monitored ion current, and sparking and defocusing tendencies appearing in the latter stages of a run as a result of lead deposits on the negative electrode. (auth)

30633 (ORNL-4127) ELECTROMAGNETIC SEPARATION AND CHEMICAL REFINEMENT OF CERIUM ISOTOPES. Henderson, W. K.; Bell, W. A.; Croft, C. R.; Sheridan, C. W.; Veach, A. M.; Love, L. O. (Oak Ridge National Lab., Tenn.). July 1967. Contract W-7405-eng-26. 25p. Dep. CFSTI.

The electromagnetic separation of cerium isotopes provided >1100 g of recovered isotopes with an isotopic purity of 35.38% for ^{136}Ce, 14.32% for ^{138}Ce, 99.70% for ^{140}Ce, and 92.77% for ^{142}Ce (natural abundance percentages – 0.193, 0.250, 88.48 and 11.07 respectively). The quantities and isotopic purities of the cerium isotopes collected were greater than those for any other cerium separation series. Modifications in operational equipment and techniques previously used were necessary to obtain these increased quantities and isotopic purities. A special two-piece pocket designed to minimize contamination was used for the collection of ^{138}Ce. This resulted in collection of ^{136}Ce of higher isotopic purity. A recessed pocket located well behind the faceplate of the receiver was used in the experimental runs for the collection of high-purity ^{136}Ce or ^{138}Ce; use of this type receiver permitted the simultaneous collection of only two masses, either ^{136}Ce or ^{138}Ce; or ^{138}Ce and ^{142}Ce; other beams struck the faceplate. Liners used on the regular runs had 5-in. spaced side shields extending the first 90° of beam trajectory except two liners, which had side shields extending 180° from source to receiver; all of these liners had 90° baffles set to pass a +10°, −4° ion beam. Liners used on experimental runs for high-purity collections had the 5-in. spaced, full length, carbon side shields and were baffled to pass ions through a +1°, −5° opening in the 90° position. Various combinations of charge materials, support gases, and activation-suppressing materials were tried in a search for stable operations. Low-fired cerium(IV) oxide [prepared by firing cerium(III) oxalate at 600°C] chlorinated internally by CCl_4 was the preferred charge material over previously prepared $CeCl_3$. Helium was a more satisfactory support gas than nitrogen, and argon was the most satisfactory of those used. Carbon disulfide used as a support gas suppressed filament activation better than argon, but its prolonged use caused detrimental deposits of carbon in the arc chamber. (auth)

30634 (SAN–651-25) ORGANIC RANKINE CYCLE TECHNOLOGY PROGRAM. Quarterly Progress Report No. 4, January 1, 1967–April 1, 1967. Adam, A. Warren (Sundstrand Aviation-Rockford, Ill.). Apr. 14, 1967. Contract AT(04-3)-651. 44p. Dep. CFSTI.

The investigation of the pyrolytic degradation of biphenyl and the eutectic mixture of biphenyl and biphenyl ether was continued. Design and fabrication of four sealed test loops for this work is virtually complete. A feasibility study is in progress to determine suitable methods of joining silicon to stainless steel with a hermetic seal. Distillation apparatus for the working fluid, which may be operated at either atmospheric pressure or vacuum, has been constructed. Bearing test rig and test loop designs are finalized and are being drafted. A plain journal bearing will be used for rig calibration. Analytical design of a full admission centrifugal pump has been completed. Design layout of the pump will begin shortly. A jet pump test fixture and loop have also been designed. Qualitative evaluation of the relative wetting capabilities of biphenyl and biphenyl–biphenyl ether eutectic on several metals is complete. Wetting characteristics are nearly all similar except that the eutectic was slightly better with 347 stainless steel and 2024 Al. Preliminary designs of the Boiler Test Loop have been completed and submitted. The purpose of this loop is to investigate heat transfer, stability, and performance characteristics of organic working fluid boilers coupled with an isotope heat source. It appears that sufficient design information is available for developing a mathematical model for the parametric design study of isotopically heated boilers (power being the parameter). (F.S.)

30635 (SGAE-IB/IA–16/1967) LABELLING OF OIL BY COLLOIDAL ^{198}Au FOR TRACER STUDIES. Donhoffer, D. K.; Duftschmid, K. E. (Oesterreichiesche Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf). 1967. 8p. Dep.

A simple method for labeling oil with colloidal gold-198 was developed and tested. The advantage over other methods is the high specific activity of the tracer which can be achieved. The stability of colloidal gold in oil was investigated in several tests and found to be sufficient for the most applications. (auth)

30636 (SGAE-PH–51/1967) PRODUCTION AND USE OF MONOISOTOPIC ION BEAMS IN AN ELECTROMAGNETIC ISOTOPE SEPARATOR. Wotke, H.; Formann, E.; Viehboeck, F. P. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Physik-Institut). 1967. 14p. Dep.

Use of the Seibersdorf electromagnetic isotope separator for production of monoisotopic ion beams at 10 to 180 keV is discussed. A device was developed to adjust the electrodes during operation of the machine in 6 directions: axial, radial, in beam direction, and rotation in these 3 directions. The production of ytterbium ion beams is discussed as an example. Uses of these ion beams are considered. (M.C.G.)

30637 (TLW–3547-1) FIRST QUARTERLY REPORT OF SNAP-9A PARTICLE STUDIES DURING OCTOBER 15, 1965–JANUARY 15, 1966. Holland, Walter D. (Tracerlab/West, Richmond, Calif.). Feb. 7, 1966. Contract AT(30-1)-3547. 49p. Dep. CFSTI.

A high altitude filter paper containing SNAP 9A debris was investigated to determine the size distribution of the particles. The portion of filter received was divided into thirty 4 cm^2 pieces and each piece low temperature ashed on a microscope slide. Ilford L-4 emulsion was added to enable radioautographic examination to disclose, by α tracking, the equivalent spherical $^{238}PuO_2$ particle sizes in a range from ~6 to 36 millimicrons. Using the alpha star results, the total estimated ^{238}Pu activity for a quadrant of the sample was 1.66 dpm. The ratio of this value to an estimate based on radiochemical analysis of an equivalent filter was 0.57. Radiochemical analysis of the stripped emulsion and ash from the scanned slides is being performed to determine the true ^{238}Pu activity on the slides. Attempts to develop techniques for direct viewing of SNAP 9-A debris particles and their alpha tracks in the electron microscope are presented. Also included are discussions of several methods being investigated to improve the accuracy of the alpha star work and decrease the time required to scan each slide. (auth)

30638 (TLW–3547-2) SECOND QUARTERLY REPORT OF SNAP-9A PARTICLE STUDIES DURING JANUARY 15–APRIL 15, 1966. Holland, Walter D. (Tracerlab/West, Richmond, Calif.). May 23, 1966. Contract AT(30-1)-3547. 49p. (TLW–1104a). Dep. CFSTI.

Five high altitude filter papers containing SNAP-9A debris were investigated to determine the size distribution of these particles. The filter portions were divided into 4 cm^2 pieces, and each piece was low temperature ashed on a microscope slide. Liquid Ilford L-4 emulsion was added to enable autoradiographic examination to disclose, by alpha track counting, the equivalent spherical $^{238}PuO_2$ particle diameters. The size distribution appears to be log normal with a mode at ~13 millimicrons and a range from 10 to ~42 millimicrons. Statistical tests disclosed that the same amounts of 1 to 5 track alpha stars were found on the one month exposures of sample, control, and blank nuclear emulsion slides. Thus it does not appear that significant numbers of 1 to 5 track stars are caused by SNAP-9A debris during one month exposures. The photoreversal technique for nuclear emulsion thin films and the "hollow" star technique, which employs another microscope slide coated with thick Kodak NTA nuclear emulsion, are presented as a combination which one expected to allow viewing submicron SNAP-9A particles directly in the electron microscope, and also determining the amount of ^{238}Pu present in each particle. (auth)

30639 (TLW–3547-3) THIRD QUARTERLY REPORT OF SNAP-9A PARTICLE STUDIES DURING APRIL 15–JULY 15, 1966. Holland, Walter D. (Tracerlab/West, Richmond, Calif.). Sept. 1966. Contract AT(30-1)-3547. 51p. (TLW–1104b). Dep. CFSTI.

Two high altitude filter papers containing SNAP-9A debris were investigated to determine the size distribution of these particles. The filter portions were divided into 4 cm^2 pieces, and each piece was low temperature ashed on a microscope slide. Liquid Ilford L-4 emulsion was added to enable autoradiographic examination to disclose, by alpha track counting, the equivalent spherical $^{238}PuO_2$ particle diameters. The size distribution appears to be lognormal with a mode at ~12 to 14 millimicrons and a range from ~8 to 30 millimicrons. Investigation of the 1 to 5 track star scanning results of sample, blank and blank IPC slides disclosed no quantitative determination of the SNAP-9A significance for alpha stars of these sizes could be made because of the large background; however, a small contribution was suggested. The hollow star technique has been considerably improved by using spacers to define the distance between the two slides. An alpha activity of 1.74 dpm with a normal standard error of ±5.3% was determined for a SNAP-9A particle isolated from A-1613-E. Four exposures were made using spacer thicknesses of 76 and 152 μ. A program to further evaluate and utilize this technique is described. (auth)

30640 (TLW–3547-4) FOURTH QUARTERLY REPORT OF SNAP-9A PARTICLE STUDIES DURING JULY 15–OCTOBER 15, 1966. Holland, Walter D. (Tracerlab/West, Richmond, Calif.). Dec. 28, 1966. Contract AT(30-1)-3547. 36p. (TLW–1104c). Dep. CFSTI.

Portions of high altitude filter samples known to contain ^{238}Pu from the SNAP-9A satellite failure were investigated to determine the size and composition of these ablation particles. A radioautographic determination of ^{238}Pu content was made to estimate the particle sizes. The samples were divided into 4 cm^2 pieces, ashed at low temperature on microscope slides, and covered with liquid nuclear emulsion. Optical microscopic examination disclosed that

alpha stars containing as many as 1,000 tracks were present on the slides which contained SNAP-9A debris. However, no stars of more than five tracks were found on either the slides of flown background or blank filters. Assuming an alpha track-disintegration conversion factor of two for all stars with SNAP-9A significance (those with more than five tracks), sufficient equivalent $^{238}PuO_2$ particle diameters were predicted from eight samples to enable the plotting of their size distributions. The distributions are log normal with a peak at 12 to 14 mμ with the particle diameter ranging from 10 to 46 mμ. Latent image fading and obscuring of alpha stars by extraneous particles on the slides have been investigated and found not to affect these results appreciably. Recent studies using similar sample, background, and blank slides exposed for one year indicate the presence of numerous SNAP-9A particles with diameters from 5 to 10 mμ which were not detected in one month exposures. The 12 mμ peak was noted in the results from the one year samples, but no mode was observable between 5 to 10 mμ. Longer exposures are planned to determine the 3 to 5 mμ range of the curve. In an effort to obtain a means for viewing SNAP-9A particles in the electron microscope, the hollow star technique was developed and found a promising aid for this purpose. The hollow star technique utilizes an exposure arrangement for two microscope slides. By knowing the exposure time, number of tracks within a selected radius of the center and the spacer distances, it is possible to calculate an equivalent $^{238}PuO_2$ diameter. By making numerous exposures of several SNAP-9A particles and using different shim thicknesses, the technique has been evaluated and found to contain no large experimental errors. The results of exposures of impactor collections of SNAP-9A debris on nitrocellulose and silicone oil coated slides are also described. In both cases, the hollow star technique has been used to detect SNAP-9A debris. These samples are particularly useful because they do not have to be ashed before being examined for SNAP-9A particles. Provided suitable methods are developed, these particles will be viewed in the electron microscope. In addition, these studies may reveal bonus information regarding the agglomeration of these particles with nonradioactive particles in the atmosphere. (auth)

30641 SYMPOSIUM ON STANDARDIZATION OF RADIONUCLIDES HELD BY THE IAEA (VIENNA, OCTOBER 10–14, 1966). Ciuffolotti, L. (Sorin, Saluggia, Italy). Energ. Nucl. (Milan), 14: 300-5(May 1967). (In Italian).

The main subjects discussed in the course of the IAEA Symposium on the standardization of radionuclides are surveyed. Useful information may be drawn from the experience gained by several laboratories in radiation detector techniques and methods of absolute measurements. (auth)

30642 NUCLEAR-ENERGIZED TURBIDITY MONITOR FOR TREATMENT PLANTS. Hirsch, A. Adler (Dept. of Water and Sewerage, Shreveport, La.). J. Amer. Water Works Ass., 59: 601-6(May 1967).

The use of radioisotopes to monitor turbidity after dark in the clearer sections of a water-treatment plant is reported. An embedded luminous disc which emits light through the activation of a phosphor by β-rays from krypton-85 is described. The device is completely self contained and self sufficient, needing no external current or power pack. The radiation hazards are inconsequential. (D.H.M.)

30643 RADIOISOTOPES IN INDUSTRY. NOTES ON CONFERENCE AT UNIVERSITY OF SOUTHAMPTON, ENGLAND, 21ST APRIL 1966. Southampton, Eng., Univ. of Southampton, 19p.

Notes are included on the following discussion topics: How radioisotopes work—Radioisotope instruments for measurement, control and analysis—Non destructive testing by gamma radiography—Radioisotopes as tracers for mixing and flow studies, for "trouble shooting", and in analysis—Radiological safety and legal requirements—Isotope powered thermoelectric generators—Advice and services available to industry. (UK)

30644 METHOD FOR PRODUCING A RADIATION LUMINOUS BODY. Murayama, Yoshihiko (to Nemoto Tokushu Kagaku Co., Ltd.). Japanese Patent 1966-8216. Apr. 28, 1966. Filed Mar. 20, 1962.

A stable and safe radiation luminous body was prepared by mixing 5 to 10 wt % of CdS with ZnS and adding 0.001 to 0.01 wt % of Cu and Ag or Au to the mixture as the activation substance. A mixture of Na, K, Ba, Mg, and ammonium chlorides was added to the other mixture. The whole was heated to a temperature at which the crystal nuclei are formed. After cooling, the mixture was crushed, and NH_4Cl added, and the crystal grown by heating to over 1000°C to obtain the fluorescent zinc cadmium sulfide crystal. The crystal was then coated with a thin film of potassium silicate which was reacted with $^{147}PmCl_3$ to form a film of insoluble promethium silicate adhering to the surface of the crystal. The film was then dried and coated with a silicone resin. (TSS)

30645 INTEGRALLY BONDED ENCAPSULATED GAMMA SOURCE. Kuhl, O. A. (to U. S. Atomic Energy Commission). U. S. Patent 3,331,962. July 18, 1967.

A gamma source consisting of a strip of cobalt-60 completely encased in stainless steel cladding which has been integrally bonded to the source material is described. (AEC)

Materials Testing

Refer also to abstracts 30991 and 31113.

30646 (NP-16806) AN EXPERIMENTAL INVESTIGATION OF FRANGIBLE PLATE FRAGMENTATION. Final Report, Summary. Liber, Theodore; Barnett, Ralph L. (IIT Research Inst., Chicago, Ill.). Oct. 1966. 99p. CFSTI.

The fragmentation of dynamically loaded homogeneous brittle plates was studied by means of a drop test facility. Multiple tests were conducted on five different size model plaster plates under two loading conditions. The results indicated that the plate response is statistical in nature and that a definite fracture pattern emerges. Furthermore, they give rise to the working hypothesis that the cracks propagate along the maximum stress trajectories associated with the forced vibration mode. (auth)

30647 DETERMINATION OF MAXIMUM TEMPERATURES ATTAINED IN IRRADIATION EXPERIMENTS. Lauritzen, T.; Comprelli, F. A. (General Electric Co., Sunnyvale, Calif.). Nucl. Appl., 3: 390-1(June 1967).

A nondestructive technique was developed to determine the maximum temperature attained in an irradiation capsule containing no external instrumentation. The technique utilizes fusible metal thermometers which have been modified to allow remote evaluation by postirradiation gamma scanning. (auth)

30648 DETERMINATION OF THE B CONTENT OF LOW-B STEEL BY MEASUREMENT OF THE FLUX DEPRESSION OF THERMAL NEUTRONS. Frevert, E. Oesterr. Akad. Wiss. Math.-Naturwiss. Kl., Sitzungsber., Abt. II, 175: 65-75(1966). (In German).

A nondestructive method was used for the determination of the B content in low-B steel using the flux depression of thermal neutrons. The detection sensitivity was approximately 0.001% B in steel. The contribution of other alloy components of the steel must be accurately known. Its effect on the neutron flux depression can be calculated with a semiempirical absorption law. A gross evaluation can be made of the homogeneity of the B distribution in the steel sample. (tr-auth)

30649 NONDESTRUCTIVE INSPECTION TECHNIQUES FOR MULTILAYER CIRCUIT BOARDS. Mathers, G. B. (North American Aviation, Inc., Anaheim, Calif.). Mater. Eval., 25: 148-52(June 1967).

X radiation, ultrasonics, and beta radiation nondestructive testing techniques were used to determine proper interconnect alignment, bond integrity, and plating thickness in the fabrication of multilayer printed circuit board systems for microelectronic computer components. (J.G.B.)

Protective Structures

Refer also to abstract 30646.

30650 (AECL-2877) DESIGN FOR RADIATION PROTECTION AT DOUGLAS POINT. Simmons, R. B. V. (Atomic Energy of Canada Ltd., Sheridan Park (Ontario)). May 1967. 62p. (CONF-670522-7). Dep. CFSTI. CAN $1.50.

From International Conference on World Review of Nuclear Reactors and Radioisotopes, Montreal, Canada.

The considerations in the Douglas Point design which provide radiation protection for the plant staff during normal operations are presented. There are two basic aspects considered: the shielding and exclusion of personnel from high radiation areas, and the limitation of personnel contact with contamination. (auth)

30651 (AWRE-E-6/67) A SURVEY OF REPORTS ON EXPERIMENTAL STUDIES OF THE FORCES EXERTED ON MODEL STRUCTURES BY THE WIND AND BY BLAST WAVES. Uppard, J. E. (Atomic Weapons Research Establishment, Aldermaston (England)). May 1967. 156p. Dep. CFSTI. UK 20s. 0d.

An extensive bibliography of the work which has been performed in many countries and over a long period of time, on the forces exerted by a flow of air, or by blast waves, on model scale structures is presented. Abstracts are given for references to the more

important experiments performed under steady flow conditions in wind tunnels, and blast-wave studies performed in shock tubes. (auth) (UK)

30652 (NP-16776) THE PREPARATION OF SIMPLIFIED MANUALS FOR SHIELDING ANALYSIS. Interim Report. Report No. 4848-1. Batter, John F.; Starbird, Albert W. (Conesco, Watertown, Mass.). Mar. 1967. Contract OCDPS-65-67. 111p.

The technology of shelter prediction from fallout radiation has advanced sufficiently to justify confidence in shelter factors computed for above-ground locations, without interior partitions, when the sheltering structure is exposed to an infinite field of contamination. For other situations, such as the basement of a structure or a field of contamination that is not infinite, either existing experimental data do not agree well with computed values or the two techniques of calculation produce conflicting results. Simplified methods of calculation are presented to accurately predict the contribution of "in and down" scattering from both interior and exterior walls to the dose rate in a below-ground area, to show the effects of limited strips of contamination on the dose rate in both above-and below-ground locations, and to predict the effects of interior walls on the dose rate in above- and below-ground areas. (D.C.C.)

30653 (NP-16776(Suppl.1)) THE PREPARATION OF SIMPLIFIED MANUALS FOR SHIELDING ANALYSIS. SUPPLEMENT ONE: IN AND DOWN SCATTERING AND FINITE FIELDS OF CONTAMINATION. Final Report. Starbird, Albert W.; Batter, John F. (Conesco, Watertown, Mass.). Mar. 1967. Contract OCDPS-65-67. 78p.

A study is described in which present and proposed methods of calculating the attenuation afforded "in and down" scattered radiation by a horizontal slab, and the effects of finite fields of contamination are discussed. The assumption used in computing the "in and down" attenuation factor, assessment on the resulting attenuation factors, and comparisons with the latest available experimental data are presented. Recommendations are provided as to "best value" factors and how they might be included in existing publications. The effects of finite fields of contamination were subjected to further analysis by directly comparing the existing method of calculation with results obtained using transmission coefficients calculated by the Monte Carlo method. This comparison, though complete only for above-ground locations, indicates that further study is required before the existing method of calculation can be relied upon. (D.C.C.)

30654 (NP-16804) SUMMARY OF COST TRENDS OF MASS PRODUCTION AS APPLIED TO 5 TO 10 PSI SHELTERS. Final Report. Curione, Charles (Stanford Research Inst., Menlo Park, Calif.). Feb. 1967. Contract OCD-PS-64-201. 82p. CFSTI.

The cost reduction potential of mass production techniques applied to 5 to 10 psi shelter construction programs is determined. Various industries employing mass production methods in the manufacture of structures or structural components were invited to provide comments pertinent to this research. Reports and studies covering shelter costs were reviewed, and applicable cost data were integrated into this report. The findings of this research indicate that some cost reduction can be achieved by use of mass production techniques where such techniques are applied to shelter construction. However, mass production does not always achieve the magnitude of cost reduction expected. (auth)

Radioactive Material Handling

30655 (BNWL-SA-1307) SAFEGUARDS SYSTEMS STUDIES. Bennett, C. A.; Granquist, D. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 15, 1967. Contract AT(45-1)-1830. 15p. (CONF-670613-1). Dep. CFSTI.

From Symposium on Safe Guards Research and Development, Argonne, Ill.

Procedures for establishing an effective inspection and control system are presented. The basic elements of the safeguard system rely on containment, surveillance, and material balance accounting. Methods for determining the effectiveness of each element, as well as applications and limitations, are presented. (D.C.C.)

30656 (CONF-660904-Vol.1 and 2, pp 509-69) ENGINEERING EVALUATION OF A RADIOACTIVE WASTE INCINERATOR. Lachapelle, David G. (Army Nuclear Defense Lab., Edgewood Arsenal, Md.).

A 50 lb/hr incinerator and associated gas-cleaning equipment for the concentration of low-level radioactive waste have been evaluated by use of non-radioactive material. Optimum operating conditions for the incinerator and the gas cleaning equipment have resulted from this investigation. These optimum operating conditions are being employed during the radiological evaluation. (auth)

30657 (CONF-660904-Vol.1 and 2, pp 570-85) DISPOSAL OF LOW LEVEL RADIOACTIVE WASTE IN COMMERCIAL INCINERATORS. First, M. W.; Zilles, P.; Walkley, J. (Harvard School of Public Health, Boston, Mass.).

A comparison was made of the performance of a crematory-type incinerator and a combination steam-boiler incinerator in the combustion of difficult laboratory and hospital wastes such as animals and cage litter. Because of excessive stack emissions of smoke, fly ash, and malodorous gases and vapors, the crematory-type proved unsatisfactory. Under the most favorable operating conditions for avoidance of air pollution and for production of a good quality residue, burning capacity was only 2 to 3 lbs/sq. ft./hr. Higher burning rates produced severe nuisances. The mechanized steam-boiler incinerator, on the other hand, provided a sanitary method for handling and burning such wastes in an efficient and rapid manner. A cyclone dust collector proved superfluous for use with gas or oil fuels and it was found that it could be eliminated without decreasing the overall collection efficiency of an electrostatic precipitator which served as a final cleaning stage. (auth)

30658 (EUR-3452.f) DECONTAMINATION DES EFFLUENTS PAR LES ZEOLITHES. (Decontamination of Effluents by Means of Zeolites). Verot, J.-L.; Blum, J.-M.; Sarfati, R.; Dagnes, J.; Cassin, Y. (Etablissements Kuhlmann, Paris (France)). Apr. 1967. 84p. (In French). Dep.

The sorbing properties of certain alkaline or earth-alkali aluminium silicates used to extract the radioelements from low and medium-activity effluents, with the aim of extending this research to high-activity effluents, are discussed. The substances studied have a high fixing capacity—200 mg of cesium and strontium, and 50 mg of cerium per gram of substance. The zeolites are employed in the form of a very fine dispersion in the effluent; studies have been carried out for a rig permitting continuous processing. The decontamination factors obtained suggest that high-activity effluents could be processed by operating in several identical stages, so as to lower the activity of the waste to the vicinity of 10^{-6} Ci/m^3. One might consider building a single plant for processing all the effluents, which would be led in at different points, according to their activity. The process studied allows of bulk retention of the cesium, strontium, cerium and zirconium ions, and their descendants. (auth)

30659 (HW-67520) THE SOURCE OF ACTIVITY CONTAINED IN RADIOACTIVE FALLOUT FROM THE REDOX 291-S STACK. Uebelacker, D. L. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Dec. 9, 1960. Contract AT(45-1)-1350. 22p. DTIE.

The results of a study to find the source of the contamination in fallouts from the Redox 291-S Stack are presented. The emissions consisted of solid white particles, fine visible particles, and a "rain" type. The highest periodic source of activity was found to be from the "C" dissolver during coating removal. At least 60% of the total stack activity was attributed to the dissolver vent system. Recommendations for improvement are presented which include the addition of a new filter system to the "A" and "C" dissolver lines, changing the coating removal procedure to force off-gas through the 293-S scrubber, and never by-passing the nitric absorber during any part of the metal dissolution step. (D.C.C.)

30660 (JAERI-4039) BIBLIOGRAPHY ON IRRADIATED FUEL SHIPPING AND ITS SHIPPING CASKS. Sawai, Sadamu; Shichi, Daisaku (Japan Atomic Energy Research Inst., Tokyo). Oct. 1966. 33p. Dep.

Present problems of shipping irradiated fuel and including shipping casks, from the standpoint of design and manufacture, are described. About 400 references are included which are divided into 12 groups according to their fields, and listed chronologically. The references are to literature published after 1959. (auth)

30661 (K-1716) PROTECTIVE SHIPPING PACKAGE FOR 5-INCH-DIAMETER UF_6 CYLINDER. Mallett, A. J.; Newlon, C. E. (Oak Ridge Gaseous Diffusion Plant, Tenn.). June 14, 1967. Contract W-7405-eng-26. 33p. Dep. CFSTI.

The design of a protective shipping package for the 5-in.-dia × 30-in. UF_6 cylinder is presented. A reinforced high-temperature phenolic foam plastic is used as a structural support and fire-resistant insulation lining. The package, which can be readily modified for shipment of other fissile materials, has received both AEC and Bureau of Explosives approval for Class II shipment of the 5-in. UF_6 cylinder at any ^{235}U enrichment. (auth)

30662 (LA-DC-8347) SOLID RADIOACTIVE WASTE DISPOSAL AT THE LOS ALAMOS SCIENTIFIC LABORATORY.

Enders, John W. (Los Alamos Scientific Lab., N. Mex.). [1965]. Contract W-7405-eng-36. 52p. (CONF-670512-6). Dep. CFSTI.

From Joint IAEA/ENEA Symposium on the Disposal of Radioactive Wastes into the Ground, Vienna, Austria.

Methods used at the Los Alamos Scientific Laboratory for the disposal of solid radioactive waste are described. Collection, transportation, and burial of waste; radiological safety of the disposal operations; and cost surveys covering a ten-year period are given. (D.C.C.)

30663 (ORNL-4003) LABORATORY DEVELOPMENT OF A PROCESS FOR INCORPORATION OF RADIOACTIVE WASTE SOLUTIONS AND SLURRIES IN EMULSIFIED ASPHALT. Godbee, H. W.; Blanco, R. E.; Frederick, E. J.; Clark, W. E.; Rajan, N. S. S. (Oak Ridge National Lab., Tenn.). July 1967. Contract W-7405-eng-26. 44p. Dep. CFSTI.

A process was developed for incorporation of aqueous intermediate- and low-level radioactive wastes in asphalt. The process is designed to prepare all of these waste types for ultimate disposal by burial or storage. Asphalt-salt mixtures containing 10 to 80 wt % salts have been prepared from three simulated wastes — ORNL evaporator concentrates, aluminum cladding solution, and a Purex second-plutonium-cycle raffinate — and three types of commercial emulsified asphalts. The composition of the emulsified asphalts as purchased was nominally 63% asphalt, 35% water, and 2% emulsifying agent. In small-scale laboratory studies, waste was introduced into emulsified asphalt at any convenient temperature below the boiling point of the solution, the water was volatilized, the temperature of the product was increased to 130–160°C, and the product was drained into a suitable container. The products that contained 70 to 80 wt % salts represented high volume reductions (volumes of waste processed per volume of product), but were not always homogeneous and free flowing, and had higher leach rates. The products containing 60 wt % salts represented a good compromise of properties: volume reduction (about 2), homogeneity, and viscosity (free flowing at 130°C). The leach rates of these asphalt products were 50 to 100 times lower than those of cement products containing similar amounts of waste salts. The leaching rates of strontium and ruthenium from these products, as determined by tests with radioactive tracers, are sufficiently low (0.1% or less leached out in 1.5 yr), but the leaching rate of cesium is 50 to 100 times higher than this. Initial tests indicate that the leach rate of cesium can be lowered satisfactorily by the addition of several weight percent of clay minerals such as grundite. External irradiation with a ^{60}Co source showed that the products have adequate stability up to an absorbed dose of 10^9 rads. In burning tests with small samples, the asphalt-salt mixtures containing 60 wt % salts, including up to 35 wt % nitrate, did not have a burning rate significantly higher than that for pure asphalt. (auth)

30664 (ORNL-NSIC-33) INDEXED BIBLIOGRAPHY ON TRANSPORTATION AND HANDLING OF RADIOACTIVE MATERIALS. Shappert, L. B. (Oak Ridge National Lab., Tenn.); Burns, R. S. (Battelle Memorial Inst., Columbus, Ohio). June 1967. Contract W-7405-eng-26. 150p. Dep. CFSTI.

Seven hundred and fifty-six abstracts of articles are presented which deal with shipping containers, shipping regulations, criticality safety as related to shipping and handling, transportation accidents, and all other items dealing with safety during the transportation and handling of radioactive materials. The type of documents referenced include topical and progress reports, transactions, journal articles, licensing and regulatory material, and patents. (D.C.C.)

30665 (RFP-936) CALCULATED CRITICAL RADII OF SPHERES OF ^{239}Pu AND ^{233}U WITH VARIOUS SPHERICAL REFLECTORS. Ferguson, Donald R.; Coonfield, Donald C. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). June 9, 1967. Contract AT(29-1)-1106. 10p. Dep. CFSTI.

Calculated critical radii of spheres of 100% plutonium-239 and 100% uranium-233 are listed as a function of reflector thickness of several types of reflectors. Corresponding critical masses are calculated using the listed critical radii. (auth)

30666 RESOLUTION BY ORDINATOR OF THE PROBLEM POSED BY THE STATUTORY HEAT TEST. Saltiel, L. Bull. Inform. Sci. Tech. (Paris), No. 114, 73-80(Apr. 1967). (In French).

Transport regulations demand proof from the senders that the transport casks can withstand an accidental fire. Programs were developed to find out the temperature changes in a composite cylinder exposed to a fire radiating according to Stefan's law. The program resolves the partial differential Fourier equation by the Crank–Nicholson method, using a recursive process of linearization of the stresses as a function of T^4 at two points of the region of integration (the external surface and the interface). The program has a self-generating time cut-off of variable interval, which affords maximum calculation speed while preventing the relative error on the temperature from exceeding a pre-determined value. (auth)

30667 HEAT PROBLEMS ENCOUNTERED IN RESEARCH ON PACKAGING. Lenail, B.; Lucas, H.; Merle, J.-P. Bull. Inform. Sci. Tech. (Paris), No. 114, 53-71(Apr. 1967). (In French).

After a brief outline of the statutory obligations and a review of the risks, the method of conducting calculations is described for packaging designed for transport of radioactive materials. Under normal conditions with the main source of heat being the residual power of the fuels, the temperatures of the cask and those of its contents are calculated step by step from the external temperatures; the methods used to lower the temperatures are mentioned briefly. Under temporary conditions (accidental conditions of fire) the problems encountered and the methods used to solve them are described. (auth)

30668 HISTORY OF THE TRANSPORT OF RADIOACTIVE MATERIALS IN FRANCE. Capet, H.; Bouillet, J. Bull. Inform. Sci. Tech. (Paris), No. 114, 7-10(Apr. 1967). (In French).

The problem of transporting radioactive materials in France is reviewed. Regulations, their extent and their effects are discussed along with industrialization of the transports. Technical research in packaging methods and economics for the future are also discussed. (P.C.S.)

30669 HEAT TRANSFER IN IRRADIATED FUEL TRANSPORT CASKS. Michel, C.; Pirovano, A.; Mordchelles-Regnier, G. Bull. Inform. Sci. Tech. (Paris), No. 114, 81-93(Apr. 1967). (In French).

Theoretical and experimental work is described, which led to the development and verification of ordinator programs enabling the temperature distribution inside and outside parallelepipedic casks, containing fuel claddings of the EDF 4 type, to be calculated. (auth)

30670 MECHANICAL PROBLEMS ENCOUNTERED IN RESEARCH ON PACKAGING. Bernard, H. Bull. Inform. Sci. Tech. (Paris), No. 114, 39-51(Apr. 1967). (In French).

Problems in mechanical testing of type B packaging are discussed relative to obtaining valid conclusions from the results. Effects due to kinetic energy stored at the moment of impact, particularly on the closing systems that must guarantee airtightness, are given. (P.C.S.)

30671 PACKAGING SAFETY CRITERIA. Bouillet, J.; Moreau, J. Bull. Inform. Sci. Tech. (Paris), No. 114, 11-12(Apr. 1967). (In French).

A revision of the 1961 International Atomic Energy Agency's safety recommendations for the transport of radioactive materials is announced. They are being adopted throughout the world in the form of international and national regulations. The basic idea is to concentrate to a maximum on the safety of the packaging. With regard to irradiation risks, the packaging-safety criteria are expressed in a certain efficiency range to which the packages must respond, according to the activity they may contain. With respect to criticality risks, these criteria are expressed by a precise set of rules and hypotheses to be respected in the calculations. The regulations throughout show an attempt to strike a balance between the admissible level of risk chosen by society and the practical needs of the laboratory and of industry. (auth)

30672 CALCULATION OF THE SHIELD OF A SPENT-FUEL SHIPPING CONTAINER. II. Hoehn, J. (VEB Kombinat Kernenergetik, Berlin. Buero fuer Entwicklung und Projektierung Kerntechnischer Anlagen, Berlin). Kernenergie, 10: 44-7(Feb. 1967). (In German).

Numerical examples of shielding calculations are presented. Methods for estimating errors in the calculations are considered. The dimensions of the transport container depend on the shielding requirements of the source material. (M.C.G.)

30673 DECONTAMINATION FACILITY FOR HEAVY EQUIPMENT. Muramatsu, Takio; Ikeda, Sachio (Ebara Mfg. Co., Ltd., Japan). FAPIG (Tokyo), No. 41, 115-17(July 1966). (In Japanese).

A decontamination facility for heavy equipment is described. In the facility, heavy equipment for the first JAPC power station, contaminated during operation, can be decontaminated. The decontamination is done in an underground bath by spraying it with a decontamination liquid, to the extent that minute parts may be decontaminated by the human hand. The facility consists of a long bath 2.5 × 2.5 × 8 m, lined with stainless steel, a truck traveling in the upper region of the bath, and the spray mechanism for the decontamination liquid, and is equipped with the devices for adjusting, locating, and providing the decontamination liquid, and

with the mist removal device in the bath. A description including the results of performance tests are also described. (NSA of Japan)

30674 TECHNICAL AND PRACTICAL DESIGN OF EXPENDABLE PACKAGING FOR RADIOISOTOPES. Vinarnick, L. Bull. Inform. Sci. Tech. (Paris), No. 115, 25-35(May 1967). (In French).

The importance and the purpose of expendable packaging for radioisotopes, particularly with respect to the returnable type are described. The component parts are also described. Selection criteria, measurement methods, and the type B packing container are then described. (auth)

30675 TRANSPORTATION PROCEDURES OF THE C.E.A. Bourdier, F. Bull. Inform. Sci. Tech. (Paris), No. 115, 37-43 (May 1967). (In French).

In view of the risks involved in the transport of radioactive materials, it has been necessary to decree a certain number of safety regulations in order to cut down the probability of an accident and, if one should occur, to limit the consequences. The practical procedures of a general nature which the user can find in the decree of July 1, 1966 (road and rail), and the procedures specific to Commissariat transports are examined. In conclusion the procedure is shown to be well founded since of 21,000 transports carried out in 9 years, not one accident caused by radioactivity has been recorded. (auth)

30676 CONSTRUCTION OF PACKING CONTAINERS FOR RADIOACTIVE MATERIALS. Labrousse, M.; Remy, J. Bull. Inform. Sci. Tech. (Paris), No. 115, 3-24(May 1967). (In French).

An outline is given of the main factors, statutory in particular, which must be taken into consideration when a packing project is being established. The resulting problems are listed and on a few special points the possible solutions are given, with emphasis in certain cases on the economic factors involved. (auth)

Vacuum Engineering

Refer also to abstracts 30594 and 30742.

30677 (UCRL-70369) DECADE OF ADVANCES IN VACUUM EQUIPMENT AND TECHNOLOGY. Batzer, T. H.; Bunshah, R. F. (California Univ., Livermore. Lawrence Radiation Lab.). June 9, 1967. Contract W-7405-eng-48. 48p. (CONF-670618-1). Dep. CFSTI.

From International Vacuum Metallurgy Conference, New York.

Improvements in construction and application of vacuum gages, windows, valves, high vacuum pumps, sputter-ion pumps, getter-ion pumps, sublimation pumps, turbomolecular pumps, cryosorption pumps, cryogenic pumps, and vacuum seals are discussed. Illustrations and diagrams are also included. (D.C.C.)

30678 (WERL-2823-26) ULTRAHIGH VACUUM TECHNIQUES. Final Report. Frauenfelder, R.; Lange, W. J.; Singleton, J. H. (Westinghouse Research Labs., Pittsburgh, Pa.). May 4, 1967. Contract AT(30-1)-2823. 38p. Dep. CFSTI.

Two experimental studies are presented: hydrogen permeation in tungsten, and the replacement of one absorbed gas by a second from a gas phase. The permeation, solubility, and diffusion constants are being determined directly and independently of one another for the first time for hydrogen permeation through tungsten. In addition to the H_2-W system some measurements have been made on the N_2-W and N_2-Mo systems as a check on both the method and for comparison with literature values. In the study of replacement of an adsorbed gas, no measurable replacement has been observed for the H_2- N_2 system on tungsten. (D.C.C.)

30679 (NP-tr-1524) THE VACUUM SYSTEM OF THE MM II EXPERIMENT. Sledziewski, Z.; Prevot, F. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Culham Lab., Eng., from report EUR-CEA-FC-377. 19p. (CTO-362). Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

A combination of oil diffusion pumps and titanium getter pumps is being used at present in the vacuum system of the MM II experiment; a new larger pumping system is about to be installed so as to obtain a total pumping speed better than 10^6 per second. Both the old and the new vacuum systems are described and some results are given. (auth)

30680 PRODUCTION OF ULTRA-HIGH VACUUM. Coutts, T. J. (Rutherford Coll. of Tech., Newcastle-upon-Tyne, Eng.). Lab. Pract., 16: 719-22; 733(June 1967).

Difficulties which occur in the production of pressures of the order of 10^{-9} torr in vessels of relatively large volume are discussed. The pressures are produced by "clean pumps" which require no moving parts and consequently no lubrication. (F.S.)

30681 DEVICE TO MOVE MECHANISMS INSIDE CHAMBERS AT ULTRAHIGH VACUUM. Martinez Guerrero, J. (Universidad Nacional de Mexico, Mexico City). Rev. Sci. Instrum., 38: 970-1(July 1967).

A brief description is given of a device designed for moving mechanisms inside chambers at extremely high vacuum. The device is of the type in which the rotating shaft is disposed within a flexible envelope and is activated by a circular movement applied to the free side of the envelope. The possibility of submitting the device to bakeout at temperatures of several hundred degrees, the simplicity of construction, and the possibility of immediate and easy reversal of motions are advantages for vacuum practice. (L.B.S.)

30682 INVESTIGATION OF THE BACK-STREAMING FROM OIL DIFFUSION PUMPS. Schulze, Helga (Institut fuer Plasmaphysik GmbH, Munich). Vakuum-Tech., 16: 102-9(May 1967).

A method of analyzing quantitatively and mass spectroscopically the pump fluid constituents back-streaming from a diffusion pump is described. Cracking of the unknown residual gas by hot filaments is prevented completely during the total pressure measurement and to a large extent during the partial pressure measurement. The back-streaming gas is accumulated in a liquid-helium or liquid-nitrogen cooled trap over a lengthy period of time. When the container is isolated at the end of the trapping time and warmed up, the pressure rises to such an extent that it can be measured with a quartz fiber gauge. The main constituents of the residual gas in the case of Octoil S were hydrogen and carbon dioxide, while the cracked products of the DC 705 and hydrogen were obtained. No evidence of CO was found in the back-streaming gas. When operating the diffusion pump with Octoil S, the back-streaming rate was higher by a factor of 300 than when operating with DC 705. (auth)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 30351, 30482, 30641, 30824, 30867, 31278, 31708, 31777, and 31835.

30683 (BMwF-FBK-67-28) ENERGIEBESTIMMUNG AN ELEKTRONEN-PHOTONEN-KASKADEN IN EMULSIONEN AUS DER WINKELVERTEILUNG. (Energy Determination on Electromagnetic Cascades in Emulsions by the Angular Distributions). Enge, W. (Kiel Univ. (West Germany). Institut fuer Reine und Angewandte Kernphysik). Apr. 1967. 27p. (In German). Dep.

Three electromagnetic cascades of energies 820, 160, and 85 GeV were measured in emulsions. Their integral angular distributions are shown to be functions of $E_0 \cdot \Theta$ (GeV • rad) in the core of the cascade, analog to the well known fact that the integral radial distributions depend on $E_0 \cdot R$ (GeV • rl) in the core of the cascade. (auth)

30684 (BMwF-FBK-67-32) UEBER EINE ANLAGE FUER RADIOKARBON-DATIERUNGEN MIT EINEM CO_2 PROPORTIONAL-ZAEHLROHR. (A CO_2 Proportional Counter Device for Radiocarbon Dating). Erlenkeuser, H. (Kiel Univ. (West Germany). Institut fuer Reine und Angewandte Kernphysik). Apr. 1967. 31p. (In German). Dep.

A description of an apparatus for radiocarbon dating is given. A copper built 4.5 l CO_2 proportional counter is used. The sensitive counter volume is screened by a tube of highly purified quartz material in order to eliminate wall contamination. The counter is surrounded by 4.5 cm of selected lead followed by 25 resp. 36 Geiger–Müller anticoincidence counters and finally by 10 cm of old lead. Working pressure is 500 Torr, up to 3 atm are possible. At 500 Torr background is 27 resp. 20 cpm. For 48h counting dating limit is 35.000 a. An analysis of background is given and a list of measurements. (auth)

30685 (BNL-11267) 14-FOOT BUBBLE CHAMBER RESEARCH AND DEVELOPMENT PROGRAM. MECHANICAL DESIGN OF MAGNET COILS. Kassner, D. A. (Brookhaven National Lab., Upton, N. Y.). Apr. 1967. 23p. (CONF-670416-2). Dep. CFSTI.

From International Colloquium on Bubble Chambers Conference, Heidelberg, Germany.

The mechanical design characteristics of superconducting magnet coils for the 7-ft bubble chamber engineering test facility, which was designed as a one-half scale model of the proposed BNL 14-ft bubble chamber, are discussed. (B.G.D.)

30686 (BNL-11382) TIME-VARIANT FILTERS FOR HIGH-RATE PULSE AMPLITUDE SPECTROMETRY. Radeka, V.; Karlovac, N. (Brookhaven National Lab., Upton, N. Y.). [1965]. 30p. (CONF-670520-3). Dep. CFSTI.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn.

The possibility of using time-variant filters to process the signals which are differentiated with a time constant very short compared to the noise-corner time constant is investigated. It was found that it is essential to vary, or switch, one filter parameter during the measurement interval in addition to switching the filter on and off at the ends of the measurement interval. With this, it becomes possible to process almost perfectly differentiated pulses (the current pulses) in a time only a little longer than theoretically required to obtain the best possible signal-to-noise ratio, and to approach that ratio. Otherwise, the effect of switching the differentiated white noise causes the signal-to-noise ratio to approach zero. Examples of simple time variant filters are given. It is shown that by using time-variant filters it is possible to avoid the dependence of the filter output on the timing uncertainty due to noise ratio. The time-variant filters proposed make possible a decrease in the actual measurement time, and a large decrease in the input filter time constant which determines the pulse tail pile-up. Thus, both the input pulse rate and the analysis rate can be higher than with time-invariant filters. (auth)

30687 (BNWL-SA-1023) DEVELOPMENT OF PORTABLE GAMMA SPECTROMETERS FOR SAFEGUARDS USE. Sheen, E. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 31, 1967. Contract AT(45-1)-1830. 16p. (CONF-670622-1). Dep. CFSTI.

From 8th Annual Meeting of the Institute of Nuclear Materials Management, Washington, D. C.

A compact, portable gamma spectrometer was developed for use by the United States Atomic Energy Commission Division of International Affairs in safeguarding inventories of ^{235}U contained in nuclear reactor unirradiated fuel elements or in various other sources. General purpose gamma spectrometry is also conveniently carried out using the instrument. Main chassis solid state circuitry, excluding the scintillation probe and preamplifier, comprises a wide-range high voltage supply, double delay line pulse amplifier, split-window gain stabilizer, single channel pulse height analyzer, six decade scaler, automatic timer, count rate meter, low voltage regulators, and a battery charger. Instrument power is supplied by a 3.5 lb, 24 V, 2 A-hr NiCd rechargeable battery, also located in the 17 × 13 × 3 inch main chassis, providing a maximum of 20 hours continuous operation. All electronic circuits, except the battery charger, are fabricated in plug-in modules each 6 × 1.5 × 3 inches in size. The main chassis mounts in a glass fiber transit case, measuring 14 × 19 × 6 inches, which provides approximately one inch of foam padding to the chassis and components. Opening the hinged transit case lid exposes the main panel and module controls for convenient use by the operator. An identical transit case with shaped padding is provided for the probe with preamplifier, collimators, and probe stand. Special considerations which permit high performance with low power circuitry are described. (auth)

30688 (CEA-R-3166) MESURE ABSOLUE D'UN FLUX ETALON DE NEUTRONS THERMIQUES PAR ACTIVATION DE DETECTEURS D'OR. (Absolute Measurement of a Standard Thermal-Neutron Flux Using Gold-Detector Activation). Paternot, Yves (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Feb. 1967. 100p. (In French). Dep.

Thesis.

The density of neutrons in a standard stocking is determined between the zero-energy and the cut-off energy of 1 mm thick cadmium unit using a gold detector. Its absolute activity is measured using a 4 π β counter calibrated for 4 π B, γ coincidence by counting strongly active sources. The correction factor F due to the disintegration process for the gold is determined experimentally. (auth)

30689 (CEA-R-3200) MESURE DE FLUX DE NEUTRONS EN RALENTISSEMENT AU MOYEN DE DETECTEURS EN SANDWICHES Au-La-Co-Mn. (Measurement of Moderated Neutron Fluxes Using Au-La-Co-Mn Sandwich Detectors). Costa, Laurent (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Mar. 1967. 100p. (In French). Dep.

Thesis. Submitted to Univ., Paris.

In order to measure the energy spectra of moderated neutrons in reactors or their protections, it is possible to improve resonating detectors by using three together: the difference between the activities of the exterior detectors and that of the central detector is proportional to the neutron flux at the resonance energy. The sensitivity obtained is lower but the energy selectivity is better than with simple detectors. The object of this work has been to develop this technique for four substances: gold, lanthanum, cobalt and manganese which have resonance energies of 4.9, 73.5, 132, and 337 eV respectively. (auth)

30690 (CONF-660904-Vol.1 and 2, pp 781-98) INCREASED DETECTION SENSITIVITY FOR ^{85}Kr. Smith, D. G.; Reist, P. C.; Silverman, L. (Harvard School of Public Health, Boston, Mass.).

A field method for increasing the sensitivity of the ionization chamber-vibrating reed electrometer system for detecting Kr-85 by use of an adsorption-desorption concentrating system was investigated. The Kr in the sample stream was concentrated by adsorbing it on an activated carbon bed at a low temperature and desorbing it into the ionization chamber at a higher temperature. A concentration factor was defined and observed to be independent of the inlet concentration of Kr-85. (auth)

30691 (COO-1545-17) SPARK LOCATION ACCURACY IN MAGNETOSTRICTIVE DELAY LINE WIRE CHAMBERS. Clifford, Thomas S.; Reibel, Kurt; Romanowski, Thomas A. (Ohio State Univ., Columbus. High-Energy Physics Lab.). May 9, 1967. Contract AT(11-1)-1545. 33p. Dep. CFSTI.

The spark location accuracy in magnetostrictive delay line wire chambers was measured with cosmic rays using prototype 8 in. × 8 in. chambers on-line to a DDP 24 Computer. For a wire spacing of 0.050 the spread varied from 0.020 to 0.040 in. (FWHM) in the eight planes used. (auth)

30692 (IFA-CRD-33) NUCLEAR SPECTROMETRY WITH FAST CURRENT PULSES FROM SEMICONDUCTOR DETECTORS. Poenaru, Dorin N. (Academia R. P. R., Bucharest. Institutul de Fizica Atomica). 1967. 20p. Dep.

The utilization of short current pulses given by L- and U-type semiconductor radiation detectors was investigated. The maximum amplitude and minimum length of the current pulses from silicon detectors were calculated and plotted against resistivity for L detectors and respective voltage for U detectors. By using a low input impedance fast transistor current-sensitive preamplifier, L-detector exponential current waveforms (for 4-MeV protons, 5- to 15-MeV α particles, and fission fragments) were verified. The possibility to employ pulses for heavy charged particle spectrometry and to obtain simultaneously fast and slow pulses from the same detector was also checked experimentally. (auth)

30693 (IN-1082) SEMICONDUCTOR COUNTING SYSTEM FOR HIGH-RESOLUTION ALPHA-PARTICLE SPECTROSCOPY. Chanda, R. N.; Deal, R. A. (Idaho Nuclear Corp., Idaho Falls). June 1967. Contract AT(10-1)-1230. 16p. Dep. CFSTI.

A high-resolution, semiconductor, alpha-particle, spectroscopy system was designed. The system employs a low-noise FET charge-sensitive preamplifier having a noise contribution of 0.77 keV silicon equivalent at 0 pf and a noise-capacitance slope of 0.028 keV/pf of input capacitance. The detector remains in constant vacuum during changing of samples, and provision is made for cooling both the detector and first stage of the preamplifier. When operated at 0°C, resolutions of <12 keV FWHM were obtained for 5.8-MeV α particles. (auth)

30694 (INR-780/XIX/D) LOW BACKGROUND BETA SCINTILLATION COUNTER. Pszona, St.; Zarnowiecki, K. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 16p. Dep.

A low level scintillation counter for β counting purpose was constructed which has a mean background count rate of 0.17 cpm at the 120 keV discrimination level. The analysis of background sources of scintillation counters is reported. (auth)

30695 (JINR-P1-3317) O TOCHNOSTI OPREDELENIYA ENERGII γ-KVANTOV V KSENONOVOI PUZYR'KOVOI KAMERE. (On the Accuracy of the γ-Quanta Energy Determination in the Xe Bubble Chamber). Ivanovskaya, I. A.; Kanarek, T.; Okhrimenko, L. S.; Slovinskii, B.; Strugal'skii, Z. S.; Chuvilo, I. V.; Yablonskii, Z. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1967. 16p. (In Russian). Dep.

The accuracy of the γ-quanta energy determination in the Xe bubble chamber is analyzed. For the γ-energy interval 40–2400 MeV it equals 12–35% according to the measurement condition. (auth)

30696 (NP-16831) A BETA SPECTROMETER ARRANGEMENT FOR MEASURING CONVERSION ELECTRON SPECTRA FROM (n,γ) REACTIONS AT THE R2 REACTOR. Baecklin, A. (Forskningradens Laboratorium, Studsvik (Sweden). Uppsala Univ. (Sweden). Inst. of Physics). 1967. 21p. (LF-16). Dep.

The 50 cm radius double focusing spectrometer for measuring (n,e$^-$) spectra was modified and connected to the Swedish research reactor, R2, at the research center, Studsvik. The equipment forming the neutron beam was reconstructed, which together with some modifications of the target and detector has considerably increased the sensitivity of the spectrometer. (auth)

30697 (RHEL/R-136, pp 131-51) EXPERIMENTAL TECHNIQUES. (Rutherford High Energy Lab., Chilton (England)).

Various experimental techniques are discussed which are used at PLA proton linear accelerator laboratory. The techniques dealt with analog fan-out (ac coupled), analog fan-in, digital pulse booster, common-base amplifier transient response, transient response of emitter-coupled current switch, V_{EB} spread for silicon planar transistors in the active region, magnetic field measurements, development of double focussing spectrometer, development of a spark chamber, spectrometer beam transport improvement, circulating liquid target, and target analyses associated with the 30 MeV (p,d) and elastic scattering observations on tin isotopes. (B.G.D.)

30698 (RT/ING-(66)25) APPARECCHIATURE DI RIVELAZIONE E CONTEGGIO DEL LABORATORIO PARAMETRI RETICOLARI DEL CNEN E MISURE DI STRUTTURE FINI DI FLUSSO NEUTRONICO. (Detection and Counting Equipment Used at the Laboratorio Parametri Reticolari of CNEN and Fine Flux Measurements). Casali, F.; Corberi, A.; Garagnani, A.; Salomoni, A.; Zappellini, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 39p. (In Italian). Dep.

In this report are shown the characteristics of some counting equipment used at Laboratorio Parametri Reticolari of CNEN Computer Center in Bologna. In particular an automatic flux scanner, low-level counting equipment, automatic γ counting equipment, gas-flow proportional counter are described in detail. Moreover some fine flux measurements are shown for uranium rods and clusters. (auth)

30699 (UCD-CNL-61) NEW INTERNAL MECHANISM FOR THE DAVIS SOLENOIDAL BETA-RAY SPECTROMETER INCLUDING POST MOMENTUM ANALYSIS BEAM FOCUSSING. Sperry, Willard C. (California Univ., Davis. Crocker Nuclear Lab.). Sept. 13, 1966. Contract AT(11-1)-Gen-10. 34p. Dep. CFSTI.

Design modifications were made for the Davis precision beta ray spectrometer in order to fulfill the following requirements: momentum resolution is to be variable from 0.001 to 0.5% FWHM, operation in the range from 0.05 to 0.5%, the Hubert baffle arrangement is to be retained, and a solid-state electron detector is to be used. (B.G.D.)

30700 (UCID-15055) FISSION CHAMBERS. Toor, Arthur (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 30, 1967. Contract W-7405-eng-48. 9p. Dep. CFSTI.

The feasibility of building fission chambers with the dual role of measuring the differential energy spectrum of neutrons from a device and making neutron fission cross-section measurements with a device used as a neutron source (both utilizing time-of-flight techniques) was investigated. The fissionable materials used in the detectors were ^{233}U, ^{235}U, ^{238}U, and ^{239}Pu. A comparison of plating techniques was made with thickness uniformity and operating reliability used as the determining criteria. Voltage counting rate characteristics were examined for several fill gases with fill pressures ranging from 1 to 5 atmospheres absolute. Some of the results of this study are summarized. (B.G.D.)

30701 (UCID-15164) SENSITIVITY OF PHOTO ELECTRIC DIODE DETECTOR FOR SOFT FLUORESCENT X RAYS. Gaines, J. L.; Leipelt, G. R. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 27, 1967. Contract W-7405-eng-48. 5p. Dep. CFSTI.

A standard photoelectric diode detector, known as a P.E.D. or XRD-4 detector, utilizing a nickel cathode was calibrated using soft fluorescent x rays. The experimental procedure was to remove the P.E.D. detector from the line of sight and count the number of photons at an NaI(Tl) detector. The P.E.D. detector was then inserted back into the line of sight and the current from this detector measured. The sensitivity versus energy is shown. (J.F.P.)

30702 (UCRL-17051) TANTALUM FAST-NEUTRON INTEGRATOR. Smith, Alan R. (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 5, 1966. Contract W-7405-eng-48. 16p. Dep. CFSTI.

A very useful fast-neutron detector consists of a slow-neutron sensitive activation element enclosed in a cadmium-clad hydrogenous moderator. When the centrally located element is surrounded by paraffin thickness of about 7 cm, detector response is nearly independent of incident fast-neutron energy throughout the range 0.2 to 20 MeV; the detector is therefore a good flux integrator for a broad region of the neutron spectrum that is of great importance to the accelerator health physicist. Among activation elements so employed, cobalt is widely used for long integration periods, especially at sites where fluxes are low enough to permit continuous occupancy. A single 56-gram cobalt disk can readily measure a flux integral of 1.0×10^7 n/cm^2 when a low-background NaI(Tl) scintillation-crystal gamma-ray spectrometer is used to assay for induced ^{60}Co activity. A flux integrator, that uses tantalum instead of cobalt, and thereby increases detector sensitivity about one order of magnitude is described. A 110-gram tantalum disk (2 in. diam by $\frac{1}{8}$ in. thick) can easily measure a flux integral of 10^6 n/cm^2, and the minimum detectable integral is almost an order of magnitude lower than this value. The observed activity in tantalum is 115-day Ta-182—a much shorter half-life than 5.26-year ^{60}Co; as a consequence, exposure periods for the tantalum flux integrator should be no longer than a few months. Although the time restriction is some disadvantage, the increased sensitivity now permits use of flux integrators in many situations important to radiation protection that were previously beyond the reach of this technique. (auth)

30703 (ANL-Trans-426) SPARK CHAMBER FILLED WITH NEON TOGETHER WITH ADMIXTURES OF ETHANOL AND WATER VAPORS. Vinogradov, A. D.; Vlasov, N. G.; Kotenko, L. P.; Merzon, G. I. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from a Russian report. 14p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The effect of admixtures of ethanol and water upon the dispersion and width of charged particle tracks was studied in a spark chamber for great delays in the feeding of the high voltage pulse $\tau_3 = 2.8 - 50$ microsec. It was found that for all τ_3-values the mean square scattering of the points of tracks is smaller approx. by 5 times in a chamber filled with Ne + C_2H_5OH than in a chamber filled with pure Ne. The dispersion of tracks in the spark chamber filled with Ne + C_2H_5OH corresponds at $\tau_3 = 0.5$ microsec.

The quality of tracks in the spark chamber filled with Ne + H_2O is somewhat worse than for a chamber filled with Ne + C_2H_5OH and considerably better than in pure Ne. (auth)

30704 (NP-tr-1552) FAST AMPLITUDE AND TIME PULSE DISCRIMINATION IN CONNECTION WITH SEMICONDUCTOR DETECTORS. Zajde, C. Translated by W. G. Stripp (Atomic Energy Research Establishment, Harwell, Eng.), from Onde Elec., 46: 819-28(1966). 25p. Dep. CFSTI, JCL $2.60 fs, $0.95 mf.

A time discriminating and amplitude analyzing system was developed which has the advantage of being simple while having a high performance with respect to speed and dynamic range. The characteristics obtained are particularly suited to the use of semiconductor detectors. It was also shown that such an arrangement is essential even in circumstances where the object is not to carry out a fine amplitude analysis, with the aid of detectors using photomultipliers for example, but where it is nevertheless necessary to know the real amplitude spectrum so as to be able to determine thresholds rapidly and reliably. Finally, methods of testing detector chains with the aid of light-emitting diodes are discussed. (auth)

30705 GERMANIUM DETECTOR AND ASSOCIATED CHARGE PREAMPLIFIER FOR γ SPECTROSCOPY. Luc, Marcus (Univ., Paris, Orsay, France). Compt. Rend., Ser. A and B, 264: 1279-82 (Apr. 24, 1967). (In French).

A charge preamplifier with low background having a resolution of 0.45 keV and a slope of 0.04 keV/pF was developed. A germanium detector associated with this preamplifier made it possible to obtain a resolution of 1.08 keV on ^{57}Co (122 keV) and of 2.2 keV on ^{60}Co (1333 keV). (tr-auth)

30706 SOLID-STATE NUCLEAR TRACK DETECTORS IN REACTOR PHYSICS EXPERIMENTS. Tuyn, J. W. N. (Institutt for Atomenergi, Kjeller, Norway). Nucl. Appl., 3: 372-4(June 1967).

Solid-state nuclear track detectors can be used in various reactor physics experiments to measure fission density distributions and fast- and thermal-neutron flux distributions. The use of a microdensitometer to determine track densities on the surface of irradiated detectors has proven to be very convenient. For fast neutron detection, comparison with activation detectors shows a higher sensitivity for the solid-state nuclear track detectors. (auth)

30707 THE X-RAY LUMINESCENCE OF AN NaCl(Ni) PHOSPHOR. Shamovskii, L. M. Opt. Spectros. (USSR) (Engl. Transl.), 22: 237-8(Mar. 1967).

Translated from Opt. Spektrosk., 22: 439-42(Mar. 1967).

In the initial stages of x-ray excitation of alkali halide phosphors containing small amounts of thallium or indium, a build-up of luminescence is observed. This is due to an increase in the inertial portion of the luminescence because of the accumulation of the light sum in shallow levels. Additional illumination in the region of F-band absorption causes an initial short optical flash, after which external quenching follows. A recombination of electrons with holes occurs outside the luminescence centers. The holes are thermally liberated by shallow levels. In these phosphors, the luminescence yield also falls off with increasing temperature because of recombination losses. The NaCl(Ni) phosphor has important peculiarities. It is shown that its luminescence is most intense at the start of excitation, and then decreases. The luminescence yield increases with increasing temperature. The study of the properties of this phosphor is of considerable interest, since luminescence occurs only in the electron stage of the recombination process; the hole stage is radiationless. It is possible to make a comparison with the properties of crystal phosphors in which luminescence occurs in the hole stage. (auth)

30708 ELECTRONIC BACKGROUND SUPPRESSION IN SCINTIGRAPHY. Potschwadek, B. (Univ., Rostock, Ger.). Radiobiol. Radiotherap., 7: 593-602(1966). (In German).

Following a brief general characterization of the conditions in scintigraphy, it is demonstrated that the digital registration is superior to the analogous one. Despite the expense, two formerly published circuits have some advantages compared with other ones. The properties of the substraction-device and of the pulse-time discriminator arise from characteristics representing the dependence of input-pulse rate on output-pulse rate. Both devices influence the statistical pulse distribution and the statistical error will be increased by this. As no difference could be found in subjective evaluation of scintigrams between the two devices, the substraction device is to be preferred because of its low expense and of the simpler way of action. (auth)

30709 DETECTION OF LOW-ENERGY CHARGED PARTICLES IN A SPARK CHAMBER. Peter, G.; Willimczik, W. (Technische Univ., Dresden). Kernenergie, 10: 52-4(Feb. 1967). (In German).

An alpha-particle spark chamber is described in which the scintillations of the filling gas are utilized for triggering the high-voltage pulses. The light yield of the scintillations is increased by applying a dc voltage field to the chamber. In a Ne/Ar/N_2 mixture memory times of about 0.6 μsec were measured. The quality of the tracks has been improved by addition of nitrogen, in which case track diameters of less than 1 mm were obtained. (auth)

30710 LIQUID SCINTILLATION COUNTING WITH A SINGLE PHOTOMULTIPLIER TUBE. Ayrey, G.; Mazza, R. J. (Univ. of London). J. Label. Compounds, 3: 24-37(Jan.-Mar. 1967).

The channels-ratio method of quench correction was found to be applicable for liquid scintillation counting of carbon-14 and tritium when a single photomultiplier is used. The relatively simple equipment is also suitable for assay of doubly labeled compounds where quenching is not important. (auth)

30711 IMPROVED COMPENSATION FILTERS FOR DOSE-RATE INDICATION WITH G-M COUNTERS INDEPENDENT OF ENERGY AND DIRECTION. Piesch, E. (Kernforschungszentrum, Karlsruhe, Ger.). Kerntechnik, 9: 198-202(May 1967). (In German).

The energy and direction dependence of the exposure-rate reading of Geiger-Mueller counters and proportional counters can be reduced by covering the counter tube with perforated metal foils. An experimental method for determining the required filter thickness and areal density will be described for different counter tubes. The G-M counter type BZ 120 yields, for example, in the energy range of 25 keV to 1.2 MeV with a filter combination for a uniform 4π radiation incidence, an energy independence of the dose-rate reading within $\pm 30\%$. Suitable filter combinations allow a direct reading of the absorbed dose rate in a given organ. (auth)

30712 MEASUREMENT OF PERSONNEL DOSE-RATE IN RADIATION PROTECTION. Frost, D. (Rudolf-Virchow-Krankenhauses, Berlin). Kerntechnik, 9: 203-4(May 1967). (In German).

For the purpose of radiation-hazard examination in civil-population protection, instruments are necessary which are simple, foolproof, and easy to read. Two methods of radiation measurement are compared: luminescent glasses and the logarithmic GM-counter ratemeter with acoustic danger signal. (auth)

30713 A BURST-CAN CHERENKOV DETECTOR FOR OPERATION AT HIGH PRESSURE. Strindehag, O. (Aktiebolaget Atomenergi, Studsvik, Sweden). Kerntechnik, 9: 194-8(May 1967).

A burst-can Cherenkov detector designed for a pressure of 100 bar is described. Measured detector efficiencies for ^{90}Y, ^{56}Mn and ^{88}Rb are given. The detector is installed in a pressurized water loop, where the recorded background count rate is normally about 210 s^{-1}, mainly due to the content of ^{56}Mn and other corrosion products in the coolant. According to calculations the count rate due to a cladding defect of pin-hole type (escape-rate coefficient 10^{-4} s^{-1}) is expected to be about 1.6×10^4 s^{-1}. (auth)

30714 DETECTOR FOR NONRELATIVISTIC QUARKS AND HEAVY SINGLE CHARGED PARTICLES. Avakyan, V. V.; Karabekov, I. P. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 2: 137-40(1967). (In Russian).

An arrangement with a large acceptance and free of physical background may be used for the detection of quarks and single charged particles with mass larger than three proton masses in nonrelativistic energy region ($\beta < 0.7$). (auth)

30715 GAS COUNTERS AND THEIR DEVELOPMENT IN CZECHOSLOVAKIA. Gilar, Oldrich; Pavlicek, Zdenek (Nuclear Instruments Research Inst., Prague). Jad. Energ., 13: 149-51(Apr. 1967). (In Czech).

In the present time the only producer of GM and proportional counters is the Nuclear Instruments Research Institute in Přemyšlení by Prague which also ensures the development of these instruments. In 1959 the production was transferred from the establishment Tesla Vrchlabí. The types and development prospects of gas-filled counters produced in Czechoslovakia are discussed. (auth)

30716 TELESCOPE ARRANGEMENT FOR CHARGED PARTICLES FROM NUCLEAR REACTIONS CAUSED BY FAST NEUTRONS. Breunlich, W. H. Oesterr. Akad. Wiss. Math.-Naturwiss. Kl., Sitzungsber., Abt. II, 175: 17-46(1966). (In German).

An investigation of the properties of a telescope arrangement for the detection of charged particles from nuclear reactions of the type (n, charged particle) showed that an arrangement which is favorable with respect to the vacuum value and the decay co-

incidences is one in which a proportional counter and a semiconductor detector were used as ΔE detectors and a semiconductor detector used as an E detector. The energy resolution in detection of charged particles can theoretically be so improved that it can be determined by the detectors used. On the basis of preparation of semiconductor detectors an energy resolution of about 50 keV should be possible. The biggest disadvantage of this detection method is that the neutron flux at the site of the detectors may not be greater than 10^6 neutrons per cm^2 sec. This means that the technically attainable π neutron fluxes can not be used and therefore in the interest of sufficient response a poor energy resolution must be accepted. In the literature values of 300 to 400 keV were given for the energy resolution but with the arrangement described values between 100 and 200 keV should be obtainable. (tr-auth)

30717 SIMPLE DEVICE FOR THE MEASUREMENT OF TRITIUM IN LIQUID SCINTILLATOR. Svoboda, Robert. Oesterr. Akad. Wiss. Math.-Naturwiss. Kl., Sitzungsber., Abt. II, 175: 47-51(1966). (In German).

The construction, measurement accuracy, and application possibilities of tritium measurement device constructed from electronic elements available in most laboratories are described. In principle it consists of a measurement head, in which the sample to be studied is introduced, and a connected electronic recorder. (J.S.R.)

30718 STUDY OF DEAD TIME OF SELF-QUENCHING G-M COUNTER. Peeva, A.; Minkova, A. (Sofia Univ.). Compt. Rend. Acad. Bulg. Sci., 18: 619-21(1965).

Applying the Stever method with an NO-4 cathode-ray oscilloscope, a study was made of three counters with the same geometry (inner cylindrical brass cathode with a 20-mm diameter and a tungsten anode-wire with a 0.2-mm diameter) and a gas mixture of alcohol/argon in a ratio of 1:10, but under different pressures: 7/70, 10/100, and 15/150. The characteristics at the corresponding temperatures were measured and the overvoltage was selected beforehand. At the 10 μs mark a counter pulse pattern was obtained on the oscilloscope screen making it possible to measure the dead time with an exactness of ±10 μs. One of the series of measurements made at constant overvoltage is shown. (J.F.P.)

30719 NUCLEAR INSTRUMENTATION. NO. 28. Instrum. Nucl. (Paris), No. 28, 1-52(1967). (In French).

Included in the material presented are a discussion of material reliability application to nuclear electronics, the fission chamber, a proportional counter with a boron deposit, the fission products detector, and the detector for fractures in the shielding for the Osiris reactor. The portable detector type, the neutron probe for the detection of criticality, the time generator type 104, the leak detector ASM4, a wattmeter–ammeter with the Hall effect and a conductivity meter without electrodes are described. Also discussed are an oil leak detector, a dry volumetric compressor for DRG, and an electromagnetic shutter for a gaseous circuit sampler for the DRG. (J.F.P.)

30720 POSSIBILITY OF THE USE OF SPARK CHAMBERS ON LINEAR ACCELERATORS. Lorikyan, M. P. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 2: 27-31 (1967). (In Russian).

An experimental method for the measurement of elastic and inelastic electron scattering and also for the investigation of some problems of photoproduction on electron linear accelerators is described. This method permits operation with a loading of 30 to 50 particles per pulse which is more than permissible electronically. (auth)

30721 INVESTIGATION OF THE COSMIC-RAY NUCLEAR-ACTIVE COMPONENT. Vardumyan, D. T.; Marikyan, G. A.; Matevosyan, K. A.; Oganesyan, A. P. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 2: 47-54(1967). (In Russian).

An arrangement is described for the investigation of the cosmic ray nuclear-active component which consists of an ionization calorimeter, spark chambers and a hodoscope system of Geiger-Mueller counters. It allows the study of the interactions of high energy nuclear-active particles, to determine their energetic spectrum and the character of the accompanying particles. (auth)

30722 A LEAK-TEST METHOD FOR HERMETICALLY SEALED SEMICONDUCTOR DEVICES UTILIZING RADIOACTIVE GAS ^{133}Xe. Veveris, O. E.; Gunne, Kh. E.; Kolmyukova, L. F.; Pelekis, L. L. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 1, 19-24(1967). (In Russian).

The equipment for immersing the metallic containers of semiconductors in the gas and the scintillation counter for gamma-radiation measuring were described. The sensitivity of this method was achieved 10^{-8} cm^3/sec by using gas of specific activity 0.1 mc/cm^3 and a scintillation counter with the sensitivity threshold 3×10^{-9} c at the immersing time in the gas chamber 1h with a 6-atm pressure differential. The error of the method and the efficiency of the equipment were estimated and the radiation safety for the personnel was considered. (auth)

30723 MAGNETIC STEERING DEVICE FOR ELECTRON COINCIDENCE EXPERIMENTS. Watson, R. L.; Rasmussen, J. O.; Bowman, H. R.; Thompson, S. G. (Univ. of California, Berkeley). Contract W-7405-eng-48. Rev. Sci. Instrum., 38: 905-9(July 1967). (UCRL-17358).

The highly convergent fringing field produced by a 100 kVA C-magnet was used to guide electrons emitted at a source around a 90° arc to a Si(Li) detector. This source-detector configuration is often desirable because it enables the electron detector to be effectively shielded from other radiations emitted at the source. The electron motion in this device consists of a superposition of a trochoidal motion and a vertical oscillation through the magnet symmetry plane. The high detection efficiency of the system (~5%) makes it particularly well suited for applications in electron coincidence experiments. Utilization of the device in a study of internal conversion in coincidence with fission is described, and several other applications are suggested. (auth)

30724 WATER VAPOR COUNTER FOR TRITIUM MEASUREMENTS. Takahashi, T.; Hamada, T. (Inst. of Physical and Chemical Research, Tokyo). Rev. Sci. Instrum., 38: 988-9(July 1967).

A cylindrical counter filled with tritiated water vapor was successfully operated using a specially designed electronic circuit. The construction, operation, and plateau characteristics are briefly described. (L.B.S.)

30725 COSMIC RAYS AS A HIGH-ENERGY PARTICLE SOURCE. Cowan, E. W.; Moe, M. K. (California Inst. of Tech., Pasadena). Rev. Sci. Instrum., 38: 874-8(July 1967).

A large cloud-chamber-ion-chamber stack was designed and operated to measure the properties of the interactions in light materials of cosmic-ray protons and pions in the energy range greater than 140 GeV. The usable flux of these particles at sea level is limited to the measured value of $(1.3 \pm 0.1) \times 10^{-4}$ m^{-2} $ster^{-1}$ sec^{-1} by the requirement that each particle be unaccompanied by time–coincident particles in the aperture of the apparatus of 0.22 m^2-ster. With the use of this flux and the apparatus described, an interaction cross section for protons in carbon can be measured for energies up to 300 GeV in about a year. In the use of the ionization spectrometer, large fluctuations in the absorption curve have been observed that preclude the use of the shape of the curve alone to measure the energy of individual events. (auth)

30726 THIN ALUMINUM FOIL SPARK CHAMBER SPECTROMETER. Hoang, T. F. (Argonne National Lab., Ill.); Niemeyer, G. L. Jr.; Phelan, J. J.; Groves, T. H. Rev. Sci. Instrum., 38: 861-6(July 1967).

A description of a thin aluminum foil spark chamber spectrometer is given. The magnet has two sets of slots to allow 90° stereo views for photography. A discussion is presented on its characteristics as well as its possible use for the measurement of high-energy γ rays. (auth)

30727 IMPROVEMENTS IN OR RELATING TO METHODS OF DETECTING CHARGED PARTICLES. Owen, Richard Bruce (to United Kingdom Atomic Energy Authority). British Patent 1,074,128. June 28, 1967. Filed Nov. 20, 1963.

A semiconductor device for detection of charged particles, which is similar to a field-effect transistor, is described. (B.G.D.)

30728 MEANS FOR EQUALIZING TWO OUTPUT SIGNALS. Rogers, E. J. (to U. S. Atomic Energy Commission). U. S. Patent 3,329,822. July 4, 1967.

A method is given for matching two direct current electric output levels by providing a servo-feedback system having an instantaneously acting long lasting memory employing a digital integrator. The described matching method is particularly applicable to flying spot systems for reading bubble chamber film where light projected through gratings onto phototransistors produces output signals that must be balanced to provide the desired film position information. (AEC)

30729 BUBBLE AND SPARK CHAMBERS. Principles and Use. Volume II. Shutt, R. P. (ed.). Pure and Applied Physics. A Series of Monographs and Textbooks. New York, Academic Press, 1967. 328p. $16.00.

The theoretical principles and technical aspects of two of the most important techniques used in high energy physics experimentation are presented. Aspects of spark chambers and of hy-

drogen, deuterium, helium, and heavy liquid bubble chambers are discussed. Specifically treated are problems of photography and magnet configuration. Emphasis is placed on data processing and on-line computer systems. Also considered are the details of production of separated beams of particles for large accelerator applications. (B.G.D.)

Radiation Dosimeters

Refer also to abstract 30406.

30730 (BRL-R-1347) GAMMA RAY INDUCED THERMOLUMINESCENCE IN THIN-FILM LiF PHOSPHORS. Coates, Arthur D.; Swisher, Joe A. (Ballistic Research Labs., Aberdeen Proving Ground, Md.). Oct. 1966. 28p. CFSTI.

Thin-film thermoluminescent dosimeters were prepared from ^{7}LiF phosphors. The techniques and conditions required for preparation and use are discussed. The thermoluminescent response of the thin-film dosimeters to cobalt-60 radiation is presented. Four different metal substrates were used as thin-film supports. The effect of these metal supports on the dose response of the thin films was investigated. The potential usefulness and some existing limitations of thin-film thermoluminescent dosimeters for gamma dosimetry are presented. (auth)

30731 (CLOR-64/D) SIMPLE FAST CHARGE-TO-PULSE CONVERTER FOR THERMOLUMINESCENCE READ-OUT DEVICE. Glowacki, St. (Centralne Laboratorium Ochrony Radiologiczne), Warsaw (Poland)). 1967. 18p. Dep.

The converter is fed by a photomultiplier viewing the light emitted by the thermoluminescent phosphor during heating. The response of the converter is linear for a wide range of input currents, ranging from 5.10^{-9} up to 10^{-3}A. The idea of the circuit is based on charging the input capacitance of the converter by the current flowing from photomultiplier to the input of the converter, and on the subsequent fast discharging of this capacitance when the voltage across it surpasses a definite value. Depending on the loading current, the frequency of the circuit may reach 0.5 MHz for the highest current of 10^{-3}A. The pulses from a discharging generator drive a scaler, indicating the total amount of emitted light. (auth)

30732 CHEMICAL DOSIMETRY OF IONIZING RADIATION. Stolz, W. (Technische Univ., Dresden). Isotopenpraxis, 3: 77-85(Mar. 1967). (In German).

A brief survey of papers dealing with chemical dosimetry of ionizing radiation and published in the last 6 years is presented. Topics discussed are: fundamentals of chemical dosimetry; liquid chemical dosimeters (dosimetry utilizing aqueous solutions of inorganic or organic substances, or organic solutions); solid-state chemical dosimeters (dosimetry by coloration of transparent colorless plastics, dosimetry utilizing solid-state organic dye systems, other solid-state organic dosimeters, dosimetry utilizing gels); and, gaseous chemical dosimeters. (124 references). (auth)

30733 LIMITATION OF THE APPLICABILITY OF IONIZATION METHODS FOR DOSIMETRY OF FAST NEUTRONS. Isaev, B. M.; Gordeev, I. V.; Bregadze, Yu. I.; Antipenko, M. V. Izmeritel. Tekh., No. 3, 46-52(Mar. 1967). (In Russian).

A method for calculation of the mean energy of ion formation in gases during ionization with neutrons of different energy is proposed. The effective energy of ionization, which takes into account the energy transfer from neutrons to molecules by heavy recoil atoms is introduced. The numerical calculations of the mean effective energy (E_{eff}) of ion formation made it possible to introduce the necessary corrections during the determination of the absorbed energy of neutrons in hydrogen-containing materials. The evaluation of the error caused by the energy dependence of the magnitude (E_{eff}) indicated the possibility of using the ionization method for the dosimetry of fast neutrons in the area of low energies. (tr-auth)

Radiometric Instruments

30734 THE POSSIBLE DETERMINATION OF THE LEVEL OF A LIQUID BY THE γ-RAY SCATTERING METHOD. Oncescu, M.; Petriu, I.; Popescu, C. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz., 19: 41-52(1967). (In Rumanian).

Experiments were carried out for determining the conditions under which scattering of the γ radiation may be used for the determination of the liquid level in closed vessels. A halide G-M counter was used in conjunction with a 1.37 ± 0.04 mCi ^{60}Co source; the detector and the source were mounted on the same side of the vessel. The intensity component due to scattering gives the useful information for the level determination. Study of the geometry of the system revealed that best results are obtained when the detector is placed as close as possible to the surface of the wall. It was also found that the sensitivity of the system is highest when the source is at the level of the liquid, varying symmetrically around that height. The sensitivity also decreases with increasing shield thickness; the optimum thickness of the shield increases with the thickness of the wall. The method presents the advantage that the activity of the detector is only slightly affected by the thickness of the liquid layer to be measured; for large thin-wall vessels, low-activity sources may be used. In case of small thin-wall containers, the scattering method offers the advantage of higher sensitivity than the attenuation method. (TTT)

30735 ARRANGEMENT FOR THE MEASUREMENT OF MOISTURE BY MEANS OF NEUTRONS. Netz, Volkhard; Johannes, Eberhard (to Veb Vakutronik Wissenschaftlicher Industriebetrieb Dresden). British Patent 1,073,443. June 28, 1967. Filed Sept. 16, 1964.

An apparatus for determining the moisture content of a substance by means of a neutron scattering technique is described. The apparatus consists of a neutron source, radiation detector, and a control device, in the form of a neutron reflector, spaced from the neutron source so that the sample can be located between the source and reflector. (B.G.D.)

Miscellaneous Instruments and Components

Refer also to abstracts 31254, 31404, and 32069.

30736 (CONF-660904-Vol.1 and 2, pp 613-24) SERIES DISTRIBUTION SAMPLING ERRORS INTRODUCED BY THE POINT PLANE ELECTROSTATIC PRECIPITATOR SAMPLING DEVICE. Reist, Parker C. (Harvard School of Public Health, Boston, Mass.).

In using the point plane electrostatic precipitator it is generally assumed that the size distribution of the sample collected represents reasonably well the actual particle size distribution of the test aerosol. This paper reports an investigation made to determine the accuracy of this assumption and concludes that for count size distributions the error introduced by this sampling device is insignificant. A list of 10 references is included. (auth)

30737 (CONF-660904-Vol.1 and 2, pp 928-40) PORTABLE SMOKE PHOTOMETER. Hunter, H. H.; Mitchell, R. I. (Battelle Memorial Inst., Columbus, Ohio).

In the evaluation of absolute filters it is necessary to challenge them with an aerosol and measure the concentration of the aerosol before and after it passes through the filter. The present procedure is to measure these aerosol concentrations with a smoke photometer which determines concentration by measuring the amount of light scattered by the aerosol particles. The amount of light scattered is proportional to the number of particles of a given size in the view volume of the instrument. The purpose of our research program is to miniaturize the smoke photometer and to increase its reliability by the use of semiconductors in place of vacuum tubes. To date, the electronics portion of the instrument has been completed and will be described in this paper. The optics portion of the instrument is still under development. (auth)

30738 (CSIR-233) A SIMPLE PULSE MULTIPLYING CIRCUIT FOR E. ΔE PARTICLE IDENTIFICATION. Burdzik, G. F.; Keizer, R. L. (Council for Scientific and Industrial Research, Pretoria (South Africa). National Physical Research Lab.). 1964. 19p. Dep.

Particles resulting from nuclear reactions, and having different charges z and masses m, may be identified by measuring their total energy E, and differential energy loss ΔE in a medium. A number of functions, based on the product E. ΔE, have been constructed, the functions being proportional to mz^2 and approximately independent of E. Particle identification, based on the properties of these expressions, is then possible. One such function, together with its analog computer, is presented here. Two adder-and-amplifier units and two logarithmic attenuators form the essential parts of the circuit. The logarithmic behavior of the attenuators is determined by a chain of biased diodes. (auth)

30739 (EUR-3177.d) ENTWICKLUNG EINES IONENBLAESERS. Schlussbericht. (Development of an Ion Blower. Final Report). Platzek, P. (Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Delft). Dec. 1966. 30p. (In German). Dep.

The experiments led to a better quantitative understanding of the influence which the independently variable parameters of a blower design have on the ion current attainable at the blower outlet. An

actual case was also used to illustrate that a simple experimental blower, if suitably designed, could neutralize the continuously induced charge. The main conclusions drawn were: (1) On the basis of known theoretical considerations formulae can be drawn up which correlate the magnitude of the bipolar ion current with the amount of radioactivity used, the air velocity and the equipment dimensions. (2) The relations derived were successfully tested, in particular, at the high air velocities at which the more interesting ion currents are obtained. (3) It was found that the diameter of the chamber in which the radioactive ion exciter is mounted plays an important part, since, if this parameter is properly selected, the ion current reaches a maximum for a given emitter quantity and air velocity. Optimization of the ion-chamber diameter was used in a patent which has been filed. (4) The maximum ion currents obtained amounted to $8\text{-}9.10^{-8}$ amps. They were produced with 80-90 mc Kr-85 at an air velocity of 50 l/sec. Such an ion current was sufficient to discharge a statically loaded, rolling plastic foil almost completely. (5) With 100 mc Kr-85 an ion current of 10^{-7} amps ought to be obtained in an ion chamber 10 cm in diameter for an air flow of 50 l/sec. A further increase in the emitter quantity and the air flow does not appear to be desirable. (auth)

30740 (LA-3692) READING SCHEDULES FOR THE MSA PARTICLE SIZE ANALYZER. Cowan, Robert E.; Gardiner, Verna L. (Los Alamos Scientific Lab., N. Mex.). Mar. 1967. Contract W-7405-eng-36. 64p. Dep. CFSTI.

Reading schedules for the MSA Particle Size Analyzer were calculated using a digital computer. A total of 1221 schedules are tabulated to cover K values between 0.80 and 40.0×10^4. (auth)

30741 (ORNL-TM-1878) SUPER-FLICKERS: AN ON-LINE DATA ACQUISITION SYSTEM FOR THE PDP-8. Rust, B. W.; Burrus, W. R. (Oak Ridge National Lab., Tenn.). June 1, 1967. Contract W-7405-eng-26. 71p. Dep. CFSTI.

SUPER-FLICKERS is a system of PDP-8 programs for accumulating and processing 4 parameter data from pulse height and time-of-flight analyzers. It writes all incoming data on magnetic tape for later analysis by a larger computer and provides oscilloscope displays of various 2-dimensional flicker boxes on an event by event basis. It also accumulates and plots certain one dimensional combination spectra which are of interest. Program options are controlled by key switches and plot scaling options are controlled by teletype keys. (auth)

30742 (RAE-TR-66158) HELIUM MASS-SPECTROMETER LEAK DETECTION. Mair, W. N. (Royal Aircraft Establishment, Farnborough (England)). May 1966. 19p. Dep. CFSTI.

The measurement of leaks in vacuum components using helium mass spectrometers is analyzed mathematically and the necessary conditions for using a simple expression for an integrated burst method of increasing sensitivity are discussed. (auth)

30743 (RISO-M-540) DESIGN OF A LOW-NOISE, CHARGE-SENSITIVE PREAMPLIFIER WITH FIELD-EFFECT TRANSISTORS. Chirilov, B. (Atomenergikommissionen, Roskilde (Denmark)). Apr. 1967. 20p. (R-4-67). Dep.

The application of field-effect transistors in nucleonic charge-sensitive preamplifiers is demonstrated. A short discussion is given of these amplifiers; particularly the noise performance is considered. On the assumption of single RC differentiating and integrating networks with equal time constants, the contributions to the equivalent noise charge from the different noise sources are found. In addition the improvement of the noise performance that might be obtained by cooling and paralleling the input FET is mentioned. Finally, the experimental results obtained with a few samples of different types of field-effect transistors are presented. (auth)

30744 (SC-DC-67-1796) ENERGY TRANSFER IN ELECTROSTATIC ARCS. Schroeder, C. F. Jr. (Sandia Corp., Albuquerque, N. Mex.). May 1967. Contract AT(29-1)-789. 12p. (CONF-670611-1). Dep. CFSTI.

From 5th Symposium on Electroexplosive Devices, Philadelphia, Pa.

In an effort to understand energy transfer phenomena in electrostatic arcs the development of reliable test instrumentation and the application of meaningful tests for electrostatic sensitivity evaluation of electroexplosive devices are described. (B.G.D.)

30745 (UCID-15151) NOTES ON POTENTIOSTAT STABILIZATION. Harrar, J. E. (California Univ., Livermore. Lawrence Radiation Lab.). May 18, 1967. Contract W-7405-eng-48. 17p. Dep. CFSTI.

A detailed description of the techniques used to stabilize the UCRL coulometer potentiostat, LE-15168, for operation with electrolysis cells in presented. The methodology is applicable to other types of potentiostats and is based on treating the potentiostat-cell system as a typical linear control system. In addition to the technique of steady-state frequency response analysis, a method of transient response testing is outlined. (B.C.D.)

30746 (UCRL-17340) CALCULATION OF TWO-DIMENSIONAL MAGNETIC FIELDS BY DIGITAL DISPLAY TECHNIQUES. Colonias, John S. (California Univ., Berkeley. Lawrence Radiation Lab.). Apr. 28, 1967. Contract W-7405-eng-48. 14p. (CONF-670705-5). Dep. CFSTI.

From 2nd International Conference on Magnet Technology, Oxford, England.

A method by which two-dimensional (including axially symmetric) magnetic fields may be calculated by utilizing digital display techniques and the manner in which this method is used in designing magnets on line with a computer system are discussed. The digital display technique used allows the experimenter to draw the magnet geometry on a cathode-ray-tube screen, it permits the use of a light pen to introduce perturbations or alter various magnet dimensions as necessary, and it displays the resulting field distribution, along with various pertinent curves at the option of the user. The computer programs utilized in this method involve existing magnetostatic programs properly modified to include axially symmetric conditions, and their speed has been increased for fast interactions with the light pen. The utilization of this method is demonstrated by the design of an axially symmetric correlation spectrometer magnet, and it is shown that the computed results have an excellent agreement with those measured. (auth)

30747 (UR-49-778) DESIGN AND PERFORMANCE OF A SIZE-SEPARATING AEROSOL CENTRIFUGE FACILITATING PARTICLE SIZE SPECTROMETRY IN THE SUBMICRON RANGE. Stober, W. (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). June 12, 1967. Contract W-7405-eng-49. 13p. (CONF-670704-4). Dep. CFSTI.

From IAEA Symposium on Instruments and Techniques for the Assessment of Airborne Radioactivity in Nuclear Operations, Vienna, Austria.

In order to facilitate a higher sampling rate without abandoning the principle of complete particle separation, efforts were made to design two instruments complying with these requirements. A prototype of one of these devices, which is still in the experimental stage, is shown. This model retains the essential features of the conifuge except for the entrance ports of both clean air and aerosol. Theoretical and experimental results for the particle deposition pattern and calibration curves for particle deposition patterns at different operating conditions are shown. (J.F.P.)

30748 COLD AND THERMIONIC ELECTRODES OF TORCH ARC. Trunecek, Vaclav (Purkyne-Univ., Brno). pp 175-82 of Third Czechoslovak Conference on Electronics and Vacuum Physics, Transactions, Held in Prague on September 23rd-28th, 1965. Paty, Libor (ed.). Prague, Publishing House of the Czechoslovak Academy of Sciences, 1967. (In German).

See CONF-650987.

The torch discharge glowing (burning) on electrodes with free electron gas is supplied with electrons by field emission. On electrodes made of isolation material or on electrolytes the torch discharge is supplied with energy only by capacity current. The current density of the capacity current is 0.1 A/cm^2. In the change of the torch discharge into the torch arc the thermionic emission asserts itself very markedly on electrodes with a high melting point. The space charge of positive ions of these electrodes is compensated by a space charge of electrons emitted by thermal field emission. This becomes apparent in the instability of the position of the torch arc on the electrode, which is manifested by the division of the electrode layer and its transference to the cooler parts of the electrode. On the surface of the electrode under the electrode layer a strong oxidation of the electrode material takes place; the arising oxide layers influence the field emission and consequently the electrode layer in different ways depending on the kind of material. In case of high output in the electrode stain of the torch arc, jets of the electrode material occur. (auth)

30749 ROLE OF AUXILIARY ELECTRODES IN AC DISCHARGES. Bito, J. (Industrial Research Ins. for Telecommunication Techniques, Budapest). pp 233-46 of Third Czechoslovak Conference on Electronics and Vacuum Physics, Transactions, Held in Prague on September 23rd-28th, 1965. Paty, Libor (ed.). Prague, Publishing House of the Czechoslovak Academy of Sciences, 1967.

See CONF-650987.

Results of an investigation were given in which the current consumption was determined for auxiliary electrodes of given size, arranged symmetrically to the main electrode, movable in a radial direction, of equal surface area, shape and material, and

their influence both at the cathode and the anode sides. Also determined were the variations of the tube voltage, the influence and deviations of the ac discharges which would take place in the cathode half cycle relative to the examined electrode. (M.O.W.)

30750 ERRORS IN PRESSURE MEASUREMENT AND IMPURITY GENERATION IN HYDROGEN USING BAYARD–ALPERT IONIZATION GAUGES. Singleton, J. H. (Westinghouse Research Labs., Pittsburgh). J. Vac. Sci. Technol., 4: 103-10(May-June 1967).

A Bayard–Alpert ion gauge, with thoria-coated electron emitters, was used to measure hydrogen pressures using emission currents as high as 10 mA without production of serious amounts of impurities. The use of high emission currents does not result in a high pumping speed and has the advantage of reducing measurement errors. Such errors result from the adsorption of carbon monoxide on the grid of the ion gauge and occur at carbon monoxide pressures as low as 0.3% of the hydrogen pressure. The total desorption probability of carbon monoxide is approximately 2×10^{-5} particles/electron, and approximately half of the gas is desorbed as ions. At high emission currents the adsorption of carbon monoxide on the grid is kept at a minimum thus reducing the spurious current to the ion collector. For example, in hydrogen at 3.5×10^{-9} Torr, in the presence of 1 to 2% carbon monoxide, the ion-gauge indication of pressure is ~10% high for operation at 10-mA electron emission, while at 100 μA the indicated pressure increases to ten times the true pressure. (auth)

30751 NUCLEAR INSTRUMENTS. Crewe, Albert V. (Argonne National Lab., Ill.). Ind. Res., 9: No. 7, 61-2; 64 (June 5, 1967).

The valuable contribution that nuclear technology has made to industry directly or indirectly is discussed. Valuable contributions to computer technology, vacuum systems, magnet design, development of high-power high-frequency vacuum tubes which have had important effects in radar development, activation analysis, electron nucroscopy, advances in air filtration, medicine, superconductivity, and fingerprint analysis are summarized. (B.G.D.)

30752 CONTRIBUTION TO THE STUDY OF ELECTRIC DISCHARGE IN VACUUM. Jamet, Francis (Institut Franco-Allemand de Recherches, Saint-Louis, France). Compt. Rend., Ser. A and B, 264: 1186-8(Apr. 17, 1967). (In French).

It is shown that the electric discharge in vacuum can be decomposed into two successive phases: the formation of the arc characterized by the emission of x-rays and a low intensity current and the arc itself characterized by the emission of light. Moreover the observation of luminous phenomena produced during the discharge makes it possible to determine that the electric arc is caused by vapors which appear successively at the anode and at the cathode. (tr-auth).

30753 OPTICAL PUMPING CLOCKS. Gourber, J.-P. (CERN, Geneva). Nucleus (Paris), 8: 27-36(1967). (In French).

The general principles of optical pumping clocks are outlined. The frequency stability of the clocks was studied with respect to the signal–noise ratio in the detection of the resonance and an examination of the stability of the resonance frequency μ_0. The development and performance of an optical pumping clock is described. (J.S.R.)

30754 MANUAL DATA ENTRY FOR MULTICHANNEL ANALYZER SYSTEM. Evans, Albert E. (Naval Ordnance Lab., Silver Spring, Md.). Rev. Sci. Instrum., 38: 980-1(July 1967).

An accessory circuit was built for the Nuclear Data Corp. model 130 AT pulse-height analyzer, which permits keyboard operation of the tape-punch driving circuits of the analyzer. The keyboard may be used to manually punch a spectrum, such as a theoretically derived pulse-height spectrum or a spectrum which has been corrected for gain shift. The spectrum may then be read into the analyzer memory for such purposes as plotting or spectrum-stripping operations. (L.B.S.)

30755 INCREASE OF MASS SPECTROMETER SENSITIVITY BY MODULATION OF THE MOLECULAR BEAM. Rutgaizer, Yu. S. Zh. Tekh. Fiz., 37: 562-5(Mar. 1967). (In Russian).

A type MKh1308 mass spectrometer was equipped with a mechanical chopper for interrupting the molecular beam at a frequency of 66 Hz in order to be able, with the aid of a resonant amplifier and a phase sensitive detector, to detect and measure low intensity mass components of the molecular beam in the presence of high intensity background lines. The device was tested by recording the mass 107 and 109 lines of silver with and without the use of the chopper and resonant amplifier, and the corresponding mass spectra are presented. It was possible to record and measure the mass 109 line from the atomic beam in the presence of a 1000 times stronger mass 109 background line. (ATD)

30756 NANOSECOND BIFILAR WOUND TRANSFORMERS. Bosshard, R.; Zajde, C.; Zyngier, H. (Ecole Normale Superieure, Orsay, France). Rev. Sci. Instrum., 38: 942-5(July 1967).

A new technique for the construction of pulse transformers using bifilar lines is described. Risetimes shorter than 0.5 nsec and decay times larger than 10 μsec may be obtained. Small size and ease of construction suggest that more elaborate transformers capable of more complicated analogue operations, such as addition or subtraction, could become practical. An example shows an arrangement which starting from two voltages, V_1 and V_2, provides $(V_1 + V_2)/2$, $(-V_1 - V_2)/2$, $(-V_1 + V_2)/2$, and $(V_1 - V_2)/2$. (auth)

30757 RETARDATION LENS USED TO IMPROVE THE ABUNDANCE SENSITIVITY OF A MASS SPECTROMETER. Freeman, N. J.; Daly, N. R.; Powell, R. E. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Rev. Sci. Instrum., 38: 945-8(July 1967).

A retardation lens has been placed between the resolving slit and the ion detector in a mass spectrometer. It has been used to reject ions that have lost significant energy by collision with residual gas atoms in the system. Several types of lens have been investigated. A considerable increase in the abundance sensitivity on both the high and low mass side of a peak results from the use of this device. (auth)

30758 DISPOZITIVE SI CIRCUITE ELECTRONICE IN INSTALATII CU IZOTOPI RADIOACTIVI. (Electronic Devices and Circuits in Installations Provided with Radioactive Isotopes). Cristea, Gh.; Grecescu, M.; Ionescu, G.; Ionescu-Muscel, C.; Popescu, Al.; Racoveanu, N.; Stan, S.; Tarina, E. Bucharest, Editura Tehnica, 1965. 616p.

The application of radioisotopes requires in most cases the use of specially designed electronic devices; in addition, health physics instrumentation must be made available for the protection of the workers. A review of the problems associated with such instruments and their circuitry is presented as a textbook. In order to make it more generally available the mathematical material was kept to a minimum, although it was assumed that the reader is familiar with electronic circuits based on tubes and transistors. The 19 chapters are organized in three main parts: Chapters 1 to 6 review the physical basis of the application of radioisotopes and the operation of the control instruments used. Chapters 7 to 14 present the principles of operation of electronic circuits; including radiation detectors, d-c and pulse amplifiers, amplitude discriminators, pulse generating circuits, coincidence and anticoincidence circuits, pulse counters, and stabilized supply sources. Chapters 15 to 19 present the most important currently available instruments fabricated in Rumania and abroad describing industrial instruments based on the use of radioisotopes, including γ scintillation spectrometers, instruments using nuclear radiation transducers, diagnostic devices, and health-physics instruments, emphasizing instruments using isotopes manufactured in Rumania. (470 references). (TTT)

30759 FLUID SENSING. Maropis, Nicholas. British Patent 1,071,734. June 14, 1967. Priority date May 21, 1963, United States.

A fluid level indicator is described for use with boiling water nuclear reactors in order to maintain a predetermined water level in the pressure vessel. (B.G.D.)

30760 SOME ANALYTICAL AND PROCESS INSTRUMENTS FOR MEASUREMENTS IN SODIUM. Duncombe, E. (United Kingdom Atomic Energy Authority, Risley, Eng.); Davies, R. A.; Davidson, D. F.; Dehn, R. Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-85/16, 24p. (CONF-661110-20). DTIE.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna.

Some recent operating experience and development work on analytical and process instruments are reviewed. The main experience with analytical instruments has concerned the rhometer and plugging meter. The influence of O_2 on the instruments was evaluated. Two general methods were developed and are described for measurement of flow rates in large ducts. Other efforts were directed to development of a differential pressure measurement instrument, measurement of liquid levels at 700°C, measurement of displacements of the order of 0.5 mm, direct immersion studies of a sheathed mineral-insulated Chromel/Alumel thermocouple in flowing Na, and leak monitoring on Na rigs. (B.L.M.)

30761 ELECTRICAL CIRCUIT FOR RAPIDLY REVERSING THE DIRECTION OF CURRENT FLOW THROUGH A MAGNETIC CORE INDUCTOR. Pechacek, Robert E. (to U. S. Atomic Energy Commission). U. S. Patent 3,331,966. July 18, 1967.

A means for periodically and rapidly reversing the polarity of a

high flux density magnetic field, in order to permit measurement of the circular polarization characteristics of gamma rays is described. Particularly, the apparatus comprises two switching means functioning in opposite conducting states, each being connected between a separate end of a first inductor and ground. A second inductor is connected between the common junction of the first inductor and one of the switching means and a power supply. A third inductor is connected between the common junction of the first inductor and the second switching means and the power supply. The conduction states of the switching means are reversed synchronously to provide a periodically reversing magnetic field. (AEC)

Radiation Effects on Instruments and Instrument Components

Refer also to abstract 31882.

30762 (FOA-4-4488-24) TRANSIENT RADIATION EFFECTS IN SEMICONDUCTOR DIODES. Sigfridsson, B.; Lindstrom, L. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). July 1966. 37p. Dep.

A description is given of some theoretical and experimental work on transient radiation effects in semiconductor diodes. Approximative expressions for the shape of the radioinduced current pulses were developed. These results were then compared to experimental results obtained for commercial diodes irradiated by x rays from a flash x-ray machine. An empirical formula for the peak value of the radioinduced current is set up as function of tabulated technical data for the diodes. (auth)

30763 (NP-16719) RADIATION TESTING OF LINEAR MICROCIRCUITS. Lieux, J. Darryl (Fairchild Semiconductor, Mountain View, Calif.). Dec. 1966. 12p.

A study was made to determine the effects of fast neutron radiation on linear microcircuits. Both overall effects and individual components were studied. Circuits tested were two operational amplifiers and two gold-doped comparators. The primary results of the tests were that one operational amplifier and the gold-doped comparators withstood up to 10^{14} nvt. The other operational amplifier withstood at least 3×10^{13} nvt. At these levels, gain was down about 50 percent on the comparators and input bias current was doubled. On the operational amplifiers, the input current showed a more severe degradation than did the gain, because more feedback was used. Other circuit parameters showed little significant change up to the levels at which the gain was halved. By measuring common-base, current-gain degradation at different current levels, it is shown that both base transport factor and emitter efficiency degrade with radiation. It was determined that diffused resistors show little change up to 10^{15} nvt. Since circuit design utilizes resistor ratios instead of absolute values, the effect is further reduced. Avalanche breakdown voltages increased due to higher resistivities, as expected. The performance changes in other components were negligible. A particularly interesting aspect of the study was to determine the sensitivity to radiation of a wide-base device, the so-called lateral PNP. Tests showed that the device was more sensitive to radiation than the NPN structures. Betas decreased by an order of magnitude at 3×10^{13} nvt. A vertical PNP also showed heavy degradation. Correlation is given between the above component changes and the overall circuit performances. It is shown that the overall gain can be made practically independent of beta. The voltage offset and current offset proved to be mostly unaffected by radiation up to 10^{14} nvt. Since the collector currents of the input stage are constant, the input bias current correlates directly to beta. (auth)

30764 EVALUATION BY SOLAR SIMULATION OF RADIATION DAMAGE IN SILICON SOLAR CELLS. Statler, Richard L. (Naval Research Lab., Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.) Trans. Electron. Devices, ED-14: 31-6 (Jan. 1967).

A survey is given of the results of radiation damage experiments where evaluation of solar-cell characteristics was done under simulated solar light. The solar cells studied were 1 and 10 ohm-cm n-on-p boron-doped cells, 5 and 10 ohm-cm aluminum-doped cells, and dendritic drift-field cells. Most of the experiments were conducted with 1-MeV electrons, and some data are given for 0.5- to 2-2-MeV electrons and 0.5- to 2.7-MeV protons. Comparisons were made between types of cells on the basis of maximum power output and power at a fixed voltage. A fixed voltage was determined for each cell type using the value of cell voltage at maximum power after a 1-MeV electron fluence of 10^{16} e/cm^2. There was an apparent lack of agreement among experimental results in the order of 3 or 4%, due to spectral variations between simulators. Another reason for the spread in data was attributed to differences that may occur between cells, even from the same manufacturer. However, taking this into account, the average power at fixed voltage for the 1 ohm-cm cells was greater than the average for 10 ohm-cm up to a fluence of 5×10^{15} e/cm^2, where a crossover occurs, and the 10 ohm-cm cells became superior. (BBB)

30765 VAN ALLEN BELT SIMULATION. Mack, Charles L. (Massachusetts Inst. of Tech., Lexington). J. Spacecraft Rockets, 4: 819-21 (June 1967).

The radiation environment at various places within a satellite and the comparative effects of spectral exposure versus monoenergetic exposure on two types of solid-state devices (2N718A and 2N2647) were investigated using the Lincoln Laboratory accelerator facility as a simulator of Van Allen energies and character (electrons and protons). (R.E.U.)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 30375, 30796, 30797, 30850, 30874, and 31955.

30766 (AERE-R-5289) INVESTIGATIONS INTO THE USE OF RADIOACTIVE ASBESTOS IN STUDYING THE TRANSLOCATION OF FIBRES INJECTED INTRAPLEURALLY INTO RATS. Holmes, A.; Morgan, A. (Atomic Energy Research Establishment, Harwell (England)). Feb. 1967. 22p. Dep. CFSTI. UK 3s. 6d.

An investigation is described which was planned to assess the possibility of using gamma-emitting radionuclides, produced in asbestos fibres by neutron activation, to trace the translocation of fibres injected into the pleura of rats. Two rats were injected intrapleurally with Rhodesian chrysotile and sacrificed after 8 and 50 days. Analysis of tissue samples and excreta, by gamma-ray scintillation spectrometry, showed that the relatively long-lived activation products (^{46}Sc, ^{51}Cr, ^{59}Fe, and ^{60}Co) were leached from the fibres at different rates in vivo. While ^{51}Cr and ^{60}Co were leached comparatively rapidly, only small amounts of ^{59}Fe and ^{46}Sc were removed from the fibres even after 50 days. The amounts of the latter remaining in the pleural cavity suggest that the amount of asbestos removed from this region into other organs in 50 days is less than 10 percent of the total injected. (auth)

30767 (BMwF-FBK-66-49) STRAHLENINDUZIERTE BIOCHEMISCHE VERAENDERUNGEN IN TUMORSTAEMMEN MIT UNTERSCHIEDLICHER STRAHLENSENSIBILITAET. (X-Ray Induced Biochemical Changes in Different Radiosensitive Tumor Strains). Schulz, K.-D. (Hamburg Univ., Eppendorf (West Germany). Frauenklinik). Dec. 1966. 21p. (In German). Dep.

Two different radiosensitive strains of the Ehrlich ascites carcinoma were investigated after 500 R to 5000 R X-rays concerning the cell kinetics, DNA-synthesis, and the DPN-content. After 2000 and 5000 R the inhibition of the cell proliferation was partially reversible. Also 500 R led to a temporary complete stoppage of cell division with full reversibility. The ^{14}C-incorporation rate into the DNA was reduced to 30% immediately after the irradiation with 2000 R. Four and 8 hours post radiation the inhibition of the DNA-synthesis reached 80%. After the same time interval 500 R caused a 30 to 40% inhibition. The DPN-content remained unchanged. Thus the DNA-synthesis is relatively radioresistant in the DNA polymerase reaction. A high radiosensitivity of the DNA-synthesis was found in cells which were irradiated in the early S-phase. (auth)

30768 (UCRL-50242) EFFECTS OF 5-FLUOROURACIL ON NORMAL SHEEP. Merkle, Theodore C.; Wilbur, David W.; Rehder, John; Silcocks, Harry (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 13, 1967. Contract W-7405-eng-48. 15p. Dep. CFSTI.

The purpose of this study was to investigate the effects of varying the dose schedule for a common cancer chemotherapy agent in a mammal of size comparable to man. The anticancer drug 5-fluorouracil was administered to healthy adult ewes in typical therapeutic doses (calculated on a weight basis) on two different time schedules (every 5 days and every 7 days). The controls were given equivalent volumes of isotonic saline solution. Effects on peripheral blood cells, behavior, food consumption, body temperature, and excretion in feces were observed. Great individual variability was found in all the reactions to the drug, and no particular correlation was found between the severity of different toxic symptoms. Neutrophil counts were reduced significantly in some but not all cases. It appears that 15 mg/kg per week can be tolerated for at least about 15 weeks. With these injection schedules, the limiting toxic symptoms seem to be erythrocyte depression and gut damage. In one sheep, however, disturbances of coordination or balance followed almost every injection. In another, 57 mg/kg was followed by death in less than 24 hours, while 30 mg/kg was followed by severe sickness in one sheep and only mild sickness in another. It appears that at least in these sheep the margin of safety for individual injections is not large. (auth)

30769 VOLATILE SULFUR COMPOUNDS IN MILK. I. EFFECT OF CHEMICAL FORM OF ^{35}S ON SELECTIVE LABELING OF MILK CONSTITUENTS AND FREE SULFUR COMPOUNDS. Pereira, R. R.; Harper, W. J.; Gould, I. A. (Ohio Agricultural Experiment Station, Columbus). J. Dairy Sci., 49: 1325-30(Nov. 1966).

The effect of different chemical forms of precursors on the ^{35}S labeling of S compounds in milk was studied, and ^{35}S-labeled milk was used to obtain information on the presence of volatile organic sulfur compounds in fluid milk and milk products. $Na_2{}^{35}S$, $Na_2{}^{35}SO_4$, or $Ba^{35}S$ were administered orally to cows in 2 to 5 mC doses, and methionine-^{35}S (1 mC) was given by intravenous infusion. Milk was withdrawn from the cows at intervals, varying from 4 to 12 hr. Preferential labeling of milk proteins was obtained with methionine-^{35}S, $Na_2{}^{35}S$, and $Ba^{35}S$, whereas preferential labeling of non-protein S was obtained with $Na_2{}^{35}SO_4$. When $Ba^{35}S$ was used, equal specific activity was found in the casein and whey protein fractions. Low concentrations (ppB) of hydrogen sulfide, mercaptans, organic sulfides, and carbonyl-^{35}S compounds were found in unheated raw milk. The type and concentration of free volatile S compounds varied with the type of sulfur compound used or with the individual cow, or both. Generally, higher concentrations of free organic sulfides were found in skim milk, cream, and rennet whey than in the original milk. Skim milk and acid whey contained higher concentrations of free mercaptans, and buttermilk contained 3 times more hydrogen sulfide than the original milk. (BBB)

30770 SPECTRA OBSERVED FROM THE LASER PLUME IN NORMAL AND MALIGNANT TISSUE OF RODENTS: A PRELIMINARY REPORT. Minton, John Peter; Merritt, J. A.; Dearman; J. R.; McKnight, W. B. (National Cancer Inst., Bethesda, Md.). Life Sci., 4: 1681-4(Sept. 1965).

An analysis was made of the emission spectra obtained from the vapors (plume) produced from normal and malignant tissue by a single high energy pulse of neodymium (10,600 Å) laser radiation. $CDBA/2F_1$ hybrid mice with a single 3-week-old subcutaneous Cloudman S91 melanoma implant in their flanks and five Sprague–Dawley rats with a similarly implanted Walker sarcoma were studied. The skin over each tumor was surgically removed and the tumor placed at the focal point of a 400-J output pulse with a 1.6-msec duration. The laser energy was optically focused to 0.5-cm dia. The vapors produced from the laser impact were spectrographically recorded in a range between 3200 and 5200 Å. Spectral analysis demonstrated that free radicals can be produced from both normal and malignant tissue by a high energy pulse of neodymium laser radiation. Strong C_2, N_2^+ 1st negative, CN, OH, and N_2 2nd positive spectra were observed. However, no CH or NH was detected. The presence of the observed free radicals suggests that sufficient energy was absorbed by the target tissue to result in a complete deterioration of molecules at that site. This hypothesis was further supported from the intensity of the spectra obtained and from the prominent spectral rotational structure observed. It was concluded that a tremendous portion of the energy from the laser radiation was absorbed at a molecular level, which resulted in the production of these highly excited free radicals. No detectable difference was observed between the free radicals produced from the malignant and normal tissue. (BBB)

30771 THE PRODUCTION OF $^{13}N_2$ BY 50-MeV PROTONS FOR USE IN BIOLOGICAL NITROGEN FIXATION. Campbell, N. E. R.; Dular, Ram; Lees, H.; Standing, K. G. (Univ. of Manitoba, Winnipeg). Can. J. Microbiol., 13: 587-600(May 1967).

An experimental system for the continuous production of radioisotopic nitrogen, $^{13}N_2$, was developed using a sector-focused cyclotron. The radioisotope was produced by 50 MeV proton bombardment of $^{14}N_2$ with powdered melamine as the nitrogen-containing target material. A trap system necessary for the removal of unwanted reaction products is described and details of experimental procedures involving changes in proton beam current and in state of beam focus are presented. Using the radioisotope, a number of microorganisms isolated from sub-Arctic soils of the Fort Churchill region were examined for their nitrogen fixation potential. Several of these, including a species of Rhodotorula and a species of Pullularia in addition to bacterial forms, demonstrated nitrogen fixation at a rate comparable with that shown by Azotobacter vinelandii. (auth)

30772 ULTRAVIOLET IRRADIATION OF DNA IN VITRO AND IN VIVO PRODUCES A THIRD THYMINE-DERIVED PRODUCT. Varghese, A. J.; Wang, Shih Yi (Johns Hopkins Univ., Baltimore). Science, 156: 955-7(May 19, 1967). (NYO-2798-31).

A new thymine-derived product was separated from DNA irradiated with ultraviolet light in vitro and in vivo. The compound was mistaken to be thymine homodimer (T = T) by other workers because it is chromatographically indistinguishable from T = T in most eluents. It has absorbancy maximums at 312, 312, and 300 millimicrons in neutral, pH 2, and pH 11 aqueous solutions, respectively. When it is irradiated in aqueous solution with wavelengths of 360 and 313 millimicrons its spectrum reverts to one similar to that of thymine. Therefore, at least three thymine-derived products can be detected in ultraviolet irradiated DNA,

namely the homodimer, a material with absorbancy maximum at 312 millimicrons, and a minor product suggested by others to be a dimer of cytosine and thymine. In cells, the latter two are formed in about equal amounts. While these three products were shown to exist in the acid hydrolyzates of ultraviolet irradiated DNA, a material with absorbance maximum at about 310 millimicrons was demonstrated to form in ultraviolet irradiated DNA without further treatment. The magnitude of this spectral increase varied directly with the increase in the adenine-thymine contents in the DNA as shown by differential transmittance spectra of the irradiated Micrococcus lysodeikticus, calf thymus, Bacillus cereus, and Hemophilus influenzae DNA. (auth)

30773 INFLUENCE OF INH AND COMBINATION OF INH WITH X IRRADIATION ON ENERGY METABOLISM OF EHRLICH ASCITES TUMOR. Moritz, Reinhart; Wagner, H. (Geschwulstklinik der Charite, Berlin). Radiobiol. Radiotherap., 7: 627-30 (1966). (In German).

The effects of isonicotinic acid hydrazide (INH) at various concentrations on respiration in Ehrlich ascites carcinoma were tested. A protective effect was demonstrated for INH against the delay of glycolysis induced by x irradiation of this tumor in vitro. (C.H.)

30774 A SENSITIVE AND SPECIFIC ENZYMATIC ISOTOPIC ASSAY FOR TISSUE HISTAMINE. Snyder, Solomon H. (Johns Hopkins Hospital, Baltimore); Baldessarini, Ross J.; Axelrod, Julius. J. Pharmacol. Exp. Therap., 153: 544-9(Sept. 1966).

A new relatively simple and rapid enzymatic-isotopic method for the estimation of histamine in biologic materials is described. Tissues are incubated with tracer amounts of ^{3}H-histomine and ^{14}C-S-adenosylmethionine in the presence of the enzyme, histamine methyl transferase, which specifically methylates histamine. ^{3}H-^{14}C-methylhistamine is the only radioactive product extracted. The ratio of $^{14}C/^{3}H$ is directly proportional to the amount of unlabeled tissue histamine present in the incubation mixture. (BBB)

30775 NATURAL RADIOACTIVITY IN SOME OCEAN REGIONS. Fedorov, Anatol F. (IAEA Lab. of Marine Radioactivity, Monaco, France). Radioact. Sea., No. 15, 1-59(1967).

Data are given on material relating to the natural radioactivity (due mainly to the β decay of ^{40}K) of sea water, of the sea bed, and of organisms occurring in various ocean regions. It is divided into five sections, each of which deals with the natural radioactivity in a particular group of organisms or in the sea itself. (auth)

30776 RADIOIODINE IN COLORADO DEER AND ELK THYROIDS DURING 1964-65. Whicker, F. Ward; Farris, Gerald C.; Dahl, Adrian H. (Colorado State Univ., Fort Collins). Contract AT(11-1)-1156. J. Wildlife Manage., 30: 781-5(Oct. 1966). (COO-1156-16).

This paper reports and discusses the levels of radioactive iodine-131 in thyroids of Rocky Mountain mule deer (Odocoileus hemionus) and elk (Cervus canadensis) in Colorado following an underground explosion at the Nevada test site and the Chinese tests in 1964 and 1965. Seventy-nine deer thyroids and 11 elk thyroids were obtained from animals collected throughout the 2-year period and quantitatively assayed for ^{131}I. Four significant responses in the ^{131}I concentrations were measured, with three of the peaks being attributed to the two Chinese tests and an underground test at the Nevada test site which reportedly vented. The other response could not be traced to any announced release of radioactivity. Radioiodine levels subsequent to each peak declined with half-times ranging from 8 to 11 days. Integrated thyroid doses calculated for each response ranged from approximately 12 to 254 mrads, which appears far below a dose required to produce thyroid adenomas. The data readily demonstrate the high sensitivity of deer and elk thyroids for environmental monitoring of ^{131}I. (auth)

30777 MECHANISM OF PHOTODIMERIZATION OF PYRIMIDINE BASES. Danilov, V. I. (Pissarzhevski Inst. of Physical Chemistry, Kiev). Photochem. Photobiol., 6: 233-5 (Mar. 1967).

The action of uv light on bacteria and phages is largely due to the intra- or intermolecular dimerization of pyrimidine bases (PB) of nucleic acids. Data suggest that this dimerization may proceed via a triplet state. Hence, theoretical examination was carried out on the PB electron structure in the lowest triplet and the lowest excited singlet states, which both play an important role in photochemical processes. Using an open-shell SCF MO LCAO method, with the operator described elsewhere, the author conducted a quantum chemical calculation of the lowest triplet state (T) of thymine, uracil, and cytosine. Some results of computation-bond orders, electron densities, and unpaired electron densities on C_5- and C_6-atoms are tabulated. According to these computations, the C_5-C_6 bond in the ground state (S_0) is practically a double one; with the transition to the triplet state the order of this bond diminishes. A considerable part of electron density on the C_5- and C_6-atoms is caused by unpaired electrons because of their preferable localization on these atoms. This considerably increases the reactivity of PB, because such a triplet state is a state of valence unsaturation. Thus, in the lowest triplet state the necessary conditions obtain for the dimerization of PB, which means a rupture of the 5, 6 π-bond with subsequent formation of a cyclobutane ring. Nevertheless, the possibility of the reaction proceeding through the lowest excited singlet state can not be excluded. The thymine 5, 6-bond order in the S_1 state is much higher than that of the T state; this indicates that dimerization via the S_1 state proceeds with more difficulty. It is noted that the calculated value of the first singlet transition for thymine (4, 71 eV) is in fair agreement with experimental results. Thus, the results show that the dimerization of PB actually proceeds via the triplet state. The C_5-C_6 bond order and the unpaired electron densities of these atoms for thymine and uracil are less than for those of cytosine, which agrees with the relative ease of photodimerization of the former. (BBB)

30778 PHOTOBIOLOGY OF RNA BACTERIOPHAGES. I. ULTRAVIOLET INACTIVATION AND PHOTOREACTIVATION STUDIES. Werbin, Harold (Southwest Center for Advanced Studies, Dallas); Valentine, Raymond C.; McLaren, A. D. Contract AT(11-1)-34. Photochem. Photobiol., 6: 205-13(Mar. 1967).

Quantum yields for the uv inactivation of intact f2 phage and of its free nucleic acid were determined. Data of this type are available only for tobacco mosaic virus, tobacco necrosis virus, and their RNA'S. Whereas single-stranded and double-stranded DNA phages that have been inactivated by uv radiation undergo photoreactivation with so-called black light (~3600 Å), RNA phages are not similarly photoreactivated. This is in contrast with the many plant viruses that can be photoreactivated by visible light. The case of tobacco mosaic virus (TMV) is somewhat unique: uv-irradiated virus is not photoreactivable but irradiated, infectious RNA is. It was of interest, therefore, to determine whether or not inactivated free, infectious RNA from phage f2 is analogous to inactivated TMV-RNA in this respect. RNA, obtained from bacteriophage f2, was inactivated by uv light (2537 Å) with a quantum yield of $3.3 \pm 0.3 \times 10^{-3}$ when assayed in the dark with protoplasts of an F^- strain of E. coli K12. Assay under black light gave a quantum yield of $2.7 \pm 0.5 \times 10^{-3}$ which was just enough lower to suggest that 17% photorecovery of the uv lesions had taken place. Intact phage f2 was inactivated by uv radiation with a quantum yield of $0.7 \pm 0.12 \times 10^{-3}$. Thus the whole phage is much less sensitive than the free RNA. No evidence of photorecovery was found in uv irradiated RNA phage 7S assayed in its host, Pseudomonas aeruginosa. (BBB)

30779 THE PHOTO-OXIDATION OF THE PEPTIDE GROUP. II. PEPTIDES AND POLYAMINO ACIDS IN SOLID STATE. Meybeck, A.; Meybeck, J. (Ecole Superieure de Chimie, Mulhouse, France). Photochem. Photobiol., 6: 365-78(May 1967). (In French).

Model experiments were performed to elucidate the uv-induced oxidation of peptides. Dipeptides, tripeptides, and tetrapeptides and synthetic polypeptides were exposed to uv light (254 nm) in the solid state and the α-keto acids in the hydrolysates were determined. Determination of glyoxylic and pyruvic acids in oligo- and polypeptides of glycine and alanine, showed that the peptide group is photo-oxidized, probably with the radical $-NH-CR-CO-$ as an intermediate. The characterization of pyruvic acid in glutathione and oxidized glutathione confirmed the photolysis of the C-S bond in combined cysteine and cystine. A comparison of the photoreactivity of peptides of the types aliphatic amino acid-aromatic amino acid and aromatic amino acid-aliphatic amino acid was the basis for the proposal of a selective mechanism for the transfer of excitation energy from the phenyl group to the preceding amino acid residue in the polypeptide chain. (BBB)

30780 EFFECTS OF X IRRADIATION ON THE ACTIVITY OF SOME HYDROLYTIC AND RESPIRATORY ENZYMES IN CORN SEEDLING ROOTS. Chang, Chong W. (Univ. of California, Riverside). Bull. Torrey Bot. Club, 93: 449-56(Nov.-Dec. 1966).

Corn seeds (Zea mays, var. Michigan hybrid 350) were germinated at the constant temperature of 25 to 27°C. Corn seedlings after 24-hr germination were treated with a single dose of 800 R of x rays at a rate of 8.5 R/min and the seedling roots were sampled at 48, 96, and 144 hr after initiation of germination. In tissue homogenate, sp activities of 2 hydrolytic enzymes and 2 respiratory enzymes were measured in comparison with control materials. The sp enzyme activity of ribonuclease and deoxyribonuclease was enhanced at the early stage of postirradiation and gradually approached the control level at the final stage. On the contrary, the sp enzyme activity of diphosphopyridine nucleotide cytochrome c reductase and succinic cytochrome c reductase was depressed initially, surpassed the normal level of enzyme activity later, and then decreased to the control values. Determination of the sp enzyme activity of subcellular fractions isolated from the corn seed-

ling roots indicated that the increased activity of 2 hydrolytic enzymes was not associated with any single subcellular fraction, while the depressed activity of 2 respiratory enzymes was due mainly to the lowered enzyme activity of mitochondria and microsome fractions. Irradiation practically did not influence the total protein contents of tissue homogenate and subcellular fractions. These data suggest that the enhanced sp hydrolytic enzyme activity was due likely to the enzyme activation caused by x rays, while the depressed sp respiratory enzyme activity was due to the enzyme inhibition influenced by x rays. (BBB)

30781 STUDIES ON THE EFFECTS OF ULTRAVIOLET IRRADIATION ON PHOTOSYNTHESIS AND ON THE 520 nm LIGHT–DARK DIFFERENCE SPECTRA IN GREEN ALGAE AND ISOLATED CHLOROPLASTS. Mantai, K. E.; Bishop, N. I. (Oregon State Univ., Corvallis). Biochim. Biophys. Acta, 131: 350-6 (Mar. 8, 1967).

Ultraviolet irradiation inhibited photosynthesis, photoreduction, Hill reaction, and the 520 nm light–dark absorbance change of algae and spinach chloroplasts. With total inactivation of these reactions the endogenous plastoquinone level dropped only about 40%. Ascorbate-2,6-dichlorophenolindophenol partially restored a 520 nm signal in 3(3,4-dichlorophenyl)-1,1-dimethylurea- or ultraviolet-treated chloroplasts, but not in petroleum ether-extracted chloroplasts. It was concluded that total destruction of endogenous plastoquinone is not the exclusive cause of ultraviolet light inhibition of photosynthesis. (auth)

30782 PHOTODIMERIZATION OF PYRIMIDINE NUCLEIC ACID DERIVATIVES IN AQUEOUS SOLUTION AND THE EFFECT OF OXYGEN. Greenstock, C. L.; Brown, I. H.; Hunt, J. W.; Johns, H. E. (Univ. of Toronto. Ontario Cancer Inst., Toronto). Biochem. Biophys. Res. Commun., 27: 431-6(May 25, 1967).

The effect of oxygen on ultraviolet-induced dimer formation in aqueous solutions of nucleic acid derivatives was examined. The uv monochromator was used to irradiate the samples. The presence of dimers was observed in orotic acid, thymine, and uracil solutions. Cytosine showed neither dimer formation nor a significant effect of oxygen. The nature of the reactions of thymine and uracil was further studied using ^{14}C-labeled bases and paper chromatography to separate individual products. Thymine was converted into two products. Uracil yielded a hydrate and several dimers; more hydrate was formed in oxygen- than in nitrogen-saturated solutions. Parameters of the proposed reaction scheme were obtained from kinetic data; the lifetime of the uracil excited state that led to dimerization was estimated to be 10^{-5} s. The fact that oxygen and other paramagnetic molecules were efficient triplet state quenchers together with the lifetime of 10^{-5} s provided some, though not conclusive, evidence that dimer formation occurred via a triplet state. (B.H.S.)

30783 THE STEREOCHEMISTRY OF THE SUCCINATE D_2O EXCHANGE AS CATALYZED BY SUCCINIC DEHYDROGENASE. Kahn, Jennifer; Rittenberg, D. (Columbia Univ., N. Y.). Biochem. Biophys. Res. Commun., 27: 484-7(May 25, 1967).

The kinetics of the enzymic oxidation of the two isomers of monodeuteriosuccinate (MDS) was investigated. Succinic dehydrogenase was prepared from fresh beef heart and then spectrophotometrically assayed; the activity of the enzyme preparation was 2.4×10^{-2} moles succinate oxidized/min/ml enzyme preparation. The D_2O exchange reaction of succinate was carried out in a mixture containing succinate, fumarate, phosphate buffer (pH 7), and the enzyme. The deuterium concentration of the final medium was 50 atom %. The exchanged succinic acid contained 37% MDS and 1.6% dideuteriosuccinate (DDS). The optical rotation of a solution of exchanged succinic acid gave zero rotation ±1 m degree at all wavelengths above 250 mμ. The data obtained illustrated that the succinate D_2O exchange led primarily to the formation of MDS. The mechanism involved in the reaction is discussed. (B.H.S.)

30784 KINETICS OF THE CELLULAR PROLIFERATION OF TWO HUMAN TUMORS STUDIED BY MEANS OF THE INJECTION OF TRITIATED THYMIDINE. Malaise, Edmond; Frindel, Emilia; Tubiana, Maurice (Institut Gustave Roussy, Villejuif, France). Compt. Rend., Ser. D, 264: 1104-7(Feb. 20, 1967). (In French).

After injection of tritiated thymidine, the proportion of labeled mitoses was measured on successive biopsies and the results were used for the calculation of the duration of the cycle phases. The duration of $G_2 + M$ is approximately 11 hr, that of S is approximately 19 hr, and the total duration of the cellular cycle seems to be of the order of three to four days. The proliferation coefficients (growth fraction) is approximately ½. (tr-auth)

30785 PHYSICAL CONSIDERATIONS INFLUENCING RADIATION RESPONSE. Pollard, Ernest C. (Pennsylvania State Univ., University Park). pp 1-30 of Biological Basis of Radiation Therapy. Schwartz, Emanuel E. (ed.). Philadelphia, J. B. Lippincott Co., 1966.

The physical character of ionizing radiation is described with particular reference to the action that it exerts on simple biological systems. Interactions of radiations with matter in ionization, the passage of fast charged particles through matter, the formation of free radicals, and the alteration of chemical bonds are discussed. Significant effects of irradiation are considered in relation to viruses, bacteria, cellular membranes, and chromosome breakage. It is suggested that radiation damage to the cell involves four processes: scission of DNA followed by enzymatic degradation; cessation of genetic transcription; reduction of the rate of DNA synthesis; and repair processes. (H.G.D.)

30786 BIOCHEMICAL MECHANISMS IN THE ACTION OF RADIATION. Shapiro, Bernard (Albert Einstein Medical Center, Philadelphia). pp 31-59 of Biological Basis of Radiation Therapy. Schwartz, Emanuel E. (ed.). Philadelphia, J. B. Lippincott Co., 1966.

Radioinduced biochemical changes are reviewed with emphasis on oxidative phosphorylation, nuclear ATP synthesis, synthesis and function of nucleic acids, enzyme activity, and protein synthesis. Radiation effects on cellular ultrastructure are discussed in relation to changes at the molecular level. (H.G.D.)

30787 ENZYME INACTIVATION BY ULTRAVIOLET IRRADIATION AND PROTECTIVE EFFECT OF MELANIN IN VITRO. Seiji, Makoto; Itakura, Hideko (School of Medicine, Tokyo). J. Invest. Dermatol., 47: 507-11(1966).

The effect of uv light (2537 Å) on the smooth-surfaced membranes isolated from Harding Passey mouse melanoma was studied. Tyrosinase, ATPase, and acid phosphatase of smooth-surfaced membranes were highly sensitive to uv; in contrast to these findings, the same enzymes of melanosomes remained intact under the same experimental conditions. Lysosomes and mitochondria isolated from rat liver were also subjected to uv radiation. Succinate dehydrogenase of mitochondria was very sensitive to the uv light. Its activity was protected by the presence of melanosomes during irradiation. The activity of acid phosphatase, which is released by uv irradiation from lysosomes and recovered from the supernatant after the centrifugation, increased with increase of the radiation dose. This effect of uv irradiation on lysosomes diminished when melanosomes were present during irradiation. Experimental results indicated that melanin protected enzymes from the uv inactivation under in vitro experimental conditions. It was suggested that the free radical nature of melanin was related to the mechanism of protection against uv light. (BBB)

30788 SYMPOSIUM ON ATOMIC ENERGY IN ANIMAL SCIENCE. II. ESTIMATION OF CARCASS LEAN MUSCLE MASS IN STEERS BY ^{40}K MEASUREMENT. Lohman, T. G.; Breidenstein, B. C.; Twardock, A. R.; Smith, G. S.; Norton, H. W. (Univ. of Illinois, Urbana). J. Anim. Sci., 25: 1218-26(Nov. 1966). (COO-1339-2).

Results are presented from a study of 42 steers relating whole-body and carcass ^{40}K contents, as measured by a large-volume, liquid scintillation counter, to carcass lean muscle mass as measured by chemical analysis. Variations in the amount of radioactivity of the gastrointestinal contents, in the counting efficiency of the whole-body counter and in the positioning of the steers with respect to the scintillation detector were found to be the main sources of error affecting the precision of estimated whole-body potassium and the precision with which the carcass lean muscle mass could be predicted. With procedures developed to account for, or minimize the above sources of variation, wholebody count was repeatable from day to day to within 2 or 3% in 21 steers and predicted carcass lean with standard errors of estimate less than 3% within two narrow weight ranges. Carcass ^{40}K measurements predicted carcass lean with standard errors of estimate somewhat greater than the whole-body count (3.5%). Body potassium can be measured precisely enough to suggest practical utility of the ^{40}K method for determining carcass lean muscle mass in live steers and in steer carcasses. (auth)

30789 EFFECT OF GAMMA RADIATION ON MEAT PROTEINS. Sukhomlinov, B. F.; Oleinik, Ya. V.; Kapis, M. V.; Belokon, E. M.; Velikii, N. N.; Nazarevich, L. E.; Kovalishin, Ya. F. Biol. Deistvie Radiats., Lvov. Gos. Univ., No. 3, 44-53 (1965). (In Russian).

The effect of high doses of γ radiation on the qualitative amino acid composition of soluble proteins in meats was investigated. The contents of glutamic acid, histidine, lysine, phenylalanine, tyrosine, and valine decreased when meat that was irradiated at a dose of 0.5 million rad was analyzed 14 days postirradiation. The ratios of aspartic acid, glutamic acid, isoleucine, leucine, threonine, tyrosine, and other amino acids changed on subse-

quent storage. The content of amino acids in the proteins, especially during storage, was markedly altered when irradiated at a dose of 1×10^6 rad. (TSS)

30790 SOLUBLE PROTEINS OF SPLEEN OF IRRADIATED ANIMALS. Makhlina, A. M. (Leningrad State Univ.). Nauch. Dokl. Vyssh. Shk. Biol. Nauki, No. 4, 77-82(1964). (In Russian).

Rats were irradiated with lethal doses of x radiation (1200 R) and then killed during the period of radiation sickness. The spleens were perfused with a cold physiological solution and protein extract was analyzed by paper electrophoresis for soluble proteins. Refractometric estimations placed the total protein contents at 2 to 3%. The distribution of protein fractions in the electrophoretic system are described; it was identical for extracts from both control and irradiated animals. When the extracts from the irradiated rats were heated at 39 to 40°C for 30 min, significant deviations from the normal electrophoretic distribution were found. (TSS)

30791 EFFECTS OF STRUCTURE AND IODINE CONTENT OF THE RAT THYROID ON THE DISTRIBUTION OF ^{127}I AND ^{131}I BETWEEN PARTICULATE AND SOLUBLE THYROIDAL PROTEIN-BOUND IODINE. Westra, J. P.; Polly, R. E.; Halmi, N. S. (Univ. of Iowa, Iowa City). Endocrinology, 79: 197-206 (July 1966).

The effects of stable iodine level in the diet, hypophysectomy, administration of goitrogens such as propylthiouracil (PTU) or $NaClO_4$, and feeding of diets rich or poor in iodine during recovery from $NaClO_4$ treatment on the distribution of ^{127}I between particulate and soluble iodoproteins and the labeling of these 2 PBI fractions with ^{131}I were studied in rat thyroids. The percentage of thyroidal $PB^{127}I$ in particulate form, ~10 in normal rats on an iodine-sufficient or iodine-deficient diet, was lowered to 2.6 in the iodine-rich, atrophic glands of hypophysectomized rats; in hyperplastic glands, whose iodine concentration was low, it ranged from 5.5 to 17.4. Both in hypophysectomized and in iodine-deficient intact rats, the percentage of thyroidal $PB^{131}I$ in the particulate fraction leveled off at 5 to 7 within 4 hr after ^{131}I injection, in spite of marked differences in thyroidal ^{131}I uptake and cellularity. In PTU- or $NaClO_4$-treated rats, on the other hand, the percentage of thyroidal $PB^{131}I$ in the particulate form rose sharply as the time after ^{131}I administration was increased, approaching or exceeding values of 50 at 4 days. (BBB)

30792 INFLUENCE OF MONOCHROMATIC UV LIGHT OF VARIOUS WAVELENGTHS ON THE MATRIX FUNCTIONS OF DNA IN THE RNA-POLYMERASE SYSTEM. Schuchmann, L.; Kroeger, H. (Univ., Freiburg i. B.). Z. Naturforsch., 22b: 503-4(May 1967). (In German).

The matrix functions of DNA in the RNA-polymerase system were limited by monochromatic uv irradiation more strongly at higher wavelengths. The synthesis of poly A was substantially less impaired by uv-irradiation than the RNA synthesis. (tr-auth)

30793 DIE ANWENDUNG RADIOAKTIVER ISOTOPE IN DER TUBERKULOSEFORSCHUNG. Zweites Internationales Symposium 1.-2. Oktober 1965, Forschungsinstitut Borstel, Institut fuer Experimentelle Biologie und Medizin. (The Use of Radioactive Isotopes in Tuberculosis Research. Second International Symposium, October 1-2, 1965, Borstel Research Institute, Institute for Experimental Biology and Medicine). Meissner, J.; Trnka, L. (eds.). Nucl.-Med., Suppl. 4, 1-215(1967). (CONF-651088).

Applications of radioisotopes in various phases of tuberculosis research are described. Topics discussed include clinical applications of ^{133}Xe in thoracography in patients with various pulmonary conditions; the use of ^{131}I-human serum albumin as a tracer to measure blood circulation, protein turn-over time, and metabolism in patients suspected of having tuberculosis of the gastrointestinal tract; the use of ^{14}C, ^{32}P, and ^{3}H as tracers in studies on the effects of various drugs on metabolism in Mycobacterium tuberculosis, the distribution of M. tuberculosis in the tissues of experimental animals; and autoradiographic techniques applicable to histopathologic investigations in specific tissues. (C.H.)

30794 ADVANCES IN TRACER METHODOLOGY. VOLUME 3. A Collection of Papers Presented at the Ninth and Tenth Symposia on Tracer Methology. Rothschild, Seymour (ed.). New York, Plenum Press, 1966. 341p. $12.50. (CONF-641025-(Vol.3); CONF-650330-(Vol.3)).

Applications of radioactive tracers in biochemistry, pharmacology, endocrinology, and medicine are discussed in 33 papers. Latest improvements in analytical techniques, such as liquid scintillation counting, autoradiography, and chromatography are described. Applications of tracer techniques in biochemical and clinical problems are discussed. The labeled substances used in these studies included glucose, glycerol, glycosides, benzene, toluene sulfonic anhydride, lecithins, aldosterone, thymidine, and cholic acid. The preparation of many of these labeled compounds is described. Typical research on which results are reported includes investigations of lipid metabolism, cancer cell metabolism, antibody synthesis, transplantation immunity, liver function, and steroid metabolism in man and research animals and photosynthesis in plants. (C.H.)

30795 RADIOAUTOGRAPHY OF PLANT TISSUES USING TRITIUM LABELED LIGNIN PRECURSORS. Saleh, Tharwat Mahmoud. Seattle, Univ. of Washington, 1966. 100p.

Research concerned with combining tritium-labeling with radioautographic methods for the purpose of studying, on site, the different phases of lignification in plant tissue as well as in individual cells is presented. Tritium-recoil labeling was used to tritiate vanillin and glucovanillin. The specific activities were low. Methods were developed to tritiate aromatic lignin precursors in tritium-containing perchloric acid solutions. Tetratritioguaiacol was recovered from 70% $TClO_4$ and used in the synthesis of 2,6-ditritiovanillin. Tritiated glucovanillin and ferulic acid were synthesized from 2,6-ditritiovanillin. Phenylalanine and tyrosine were tritiated at the aromatic ring directly in 50% $TClO_4$. The dilution was necessary to obtain enough solubility. Ferulic acid was tritiated in one-step reaction in tritium-containing perchloric acid-dioxane mixture. Tritiated ferulic acid was recovered from this mixture in excellent radioactivity yields. The tritiated precursors were administered to living plants by three different methods: implantation under bark, injection with needles, and absorption through cut ends. The precursors were allowed to be metabolized by plants. Radioautograms of cross sections were prepared. The interpretation of the radioautograms revealed the different phase of lignification in tissue as well as in single cells. Radioautograms of wheat plants revealed the trend of lignification in vascular bundles at different levels of the stem. The results indicated that vessels complete lignification first, followed by other sclerenchyma cells in the bundle. The parenchyma cells were shown to complete lignification last. Radioautograms of cottonwood plant revealed the different phases of lignification in maturing secondary wood and in primary xylem. The results showed that lignification started at the corners in primary cell walls and advanced to primary cell walls and intercellular layers. There were indications that the corners required more time to complete lignification. The fact that radioactivity was detected in the primary xylem showed that the cells of this tissue were living cells. Radioautograms of Douglas fir demonstrated that ferulic acid was not used in the synthesis of lignin. The radioactive precursor was deposited as artifacts in the corners of cells adjacent to ray cells or in the cell lumen of old wood. (auth)

Ecology

Refer also to abstract 30541.

30796 (COO-1523-6) TRANSFER OF MATTER AND ENERGY FROM HERBIVORES TO CARNIVORES. Technical Progress Report, May 21, 1966-May 20, 1967. Davis, Charles C. (Western Reserve Univ., Cleveland, Ohio. Dept. of Biology). Contract AT(11-1)-1523. 23p. Dep. CFSTI.

Progress is reported on a study on the transfer of matter and energy from herbivores to carnivores. Data are presented on the wet weight, dry weight, ash weight, organic matter weight, oxygen consumption, and CO_2 production by guppies (Lebisthes reticulatus) maintained on a mixed diet containing the crustacean Daphnia and on the weight of the small fish Tilapia mozambica fed a diet of Daphnia only. The number of Daphnia required daily to exactly maintain initial weight of the fish and the number required daily to allow for maximum growth of the fish was calculated. The Daphnia were fed on algae (Chlamydomonas reinhardi) and the number of algae required for each Daphnia to reach maximum size was also calculated. Factors influencing the efficiency with which foods contribute to growth are discussed. (26 references.) (C.H.)

30797 (ORNL-P-3082) ^{14}C CYCLING IN THE ROOT AND SOIL COMPONENTS OF A PRAIRIE ECOSYSTEM. Dahlman, Roger C. (Oak Ridge National Lab., Tenn.); Kucera, Clair L. (Missouri Univ., Columbia). [1967]. Contract W-7405-eng-26. 21p. (CONF-670503-12). Dep. CFSTI.

From 2nd National Symposium on Radioecology, Ann Arbor, Mich.

Tall grasses of a central Missouri native prairie were labeled with $^{14}CO_2$ in polyethylene enclosures during late summer in order to study carbon transfer from foliage to the roots and from roots to soil organic matter. Six-week-old regenerated foliage assimilated six to eight times more of the radiocarbon than foliage which was approaching maturity. Approximately 60 and 85 percent of the assimilated label was translocated to the root system in regener-

ated and mature plants respectively. Similar quantities of radiocarbon were present in roots collected from both mature and regenerated areas because of differential translocation processes. Over a two-year period, ^{14}C disappearance from the 0 to 10 inch depth of the root system followed a linear trend as described by the regression $Y = 27.1 - 0.52X$, where Y is radioactivity and X is time in months. This relationship suggests that the root system undergoes turnover approximately every four years. Roots deeper in the profile exhibited a slower rate of ^{14}C disappearance, and a near-equilibrium condition between loss to the soil and input from translocation was approached. Maximum cumulative transfer of ^{14}C from the roots to the soil was observed 10 to 14 months after assimilation of the label when approximately 45% of the cumulative ^{14}C loss from roots was present in the soil organic matter. Fourteen to 26 months later the ^{14}C present in the soil decreased to 9% of the cumulative loss from roots, indicating that most of the early decay products were rapidly decomposed by the soil microbes. Both the rapid transfer from roots to soil and the large fraction of decay products which disappeared as CO_2 indicate a rather short residence time for most organic materials in these parts of the carbon cycle. (auth)

Genetics and Cytogenetics

Refer also to abstracts 30928 and 30931.

30798 INVESTIGATIONS OF NUCLEAR INJURIES AND INHIBITION OF GROWTH IN 14- AND 28-CHROMOSOME FORMS OF RYE ON IRRADIATION WITH FAST NEUTRONS. Safin, M. K.; Demchenko, V. E. (Inst. of Botany, Kiev). Ukr. Bot. Zh., 22: No. 6, 30-5(1965). (In Ukrainian).

The incidence of cells with chromosomal aberrations was higher in sprouts of autotetraploid rye than in diploid rye. However, with respect to growth, 28-chromosome rye proved to be considerably more radioresistant to fast neutrons than the 14-chromosome variety. (auth)

30799 CHROMOSOMAL CHANGES OF SIMILAR NATURE IN SEVEN ESTABLISHED CELL LINES DERIVED FROM THE PERIPHERAL BLOOD OF PATIENTS WITH LEUKEMIA. zur Hausen, Harald (Children's Hospital, Philadelphia. Univ. of Pennsylvania, Philadelphia). J. Nat. Cancer Inst., 38: 683-8 (May 1967).

Seven cell lines derived from the peripheral blood of leukemic patients were examined cytogenetically. All strains had predominantly diploid chromosome numbers. In a few metaphases, incomplete condensation of single chromosomes involved chiefly chromosomes that were affected by secondary constrictions. In anaphase preparations the uncoiled material failed to move in step with the divided chromosomes and was easily detected. Autoradiography with tritiated thymidine revealed DNA synthesis of incompletely condensed material during the G2 period; this indicated a disturbed DNA replication pattern of the involved chromosomes. The implications of these findings are discussed. (auth)

30800 A DEVELOPMENTAL STUDY OF DIPLOID OATS BY MEANS OF RADIATION-INDUCED SOMATIC MUTATIONS. Ichikawa, S.; Ikushima, T. (Kyoto Univ.). Radiat. Bot., 7: 205-15 (June 1967).

The developmental behavior of radiation-induced mutant cells in X_1 plants was studied using a strain of diploid oats heterozygous for the albino gene, al. Dry and 24-hr pre-soaked seeds were irradiated with X-rays, γ-rays and thermal neutrons. Distinct white stripes were observed in leaf 3 and upper leaves when dry seeds were irradiated, but from leaf 2 when pre-soaked seeds were treated. The different response in the pre-soaked seeds might be caused by the radiation-induced loss of reproductive integrity of most of the sensitized leaf 2 primordial cells, followed by reorganization of the primordia in the embryos. The number of white stripes per leaf decreased with the progression of leaf order. From the relative widths of the stripes, the number of primordial or initial cells for each leaf in the mature embryos was estimated to be about 30 or less for leaf 3 and at least three to five for leaf 4 to leaf 6. Since the stripes in leaf 3 from the treated dry seeds were induced independently from those in the upper leaves, leaf 3 seems to have been derived from an already differentiated primordial cell group, although such a group could not be detected histologically. The white stripes were more frequently observed near the centre of the leaf blade rather than in the marginal part, with wider stripes tending to appear in the marginal region, indicating a differential development in the lateral direction. The tillers on the same orthostichy tended to behave similarly with regard to the appearance of the white stripes or sectors. The study demonstrated that mutations having an appropriate phenotype induced in somatic tissues provide a useful means for detailed study of organogenesis in higher plants. (auth)

30801 THE RELATIONSHIP BETWEEN DEVELOPMENTAL STAGES OF FLOWER-BUDS AND SOMATIC MUTATIONS INDUCED BY ACUTE X- AND CHRONIC GAMMA-IRRADIATION IN COSMOS BIPINNATUS. Gupta, M. N.; Samata, Y. (Tokyo Univ.). Radiat. Bot., 7: 225-40 (June 1967).

Experiments were conducted on the effects of acute x- and chronic γ-irradiation on Cosmos bipinnatus of different stages of flower development, with particular reference to the induction of somatic mutations. Clone I was heterozygous both for flower colour and flower type, while Clone II was heterozygous for flower colour only. Stage of flower development was controlled by giving short-day treatment prior to irradiation. Plants were irradiated with 2 kR of x-rays at the vegetative stage and after 10, 20 and 27 days of short-day treatment. For chronic irradiation two groups of growing plants of Clone I were transplanted to the gamma field, and received a total exposure of about 3 and 2 kR of γ-rays. Somatic mutations appeared as narrow streaks to wide sectors of red, light pink and white colours on a background of normal colour of the ray florets. The maximum number of flowers with mutations occurred in Clone I after 20 days of short-day treatment. The relative frequency of flowers with colour mutations varied with the clone and stage of flower development at the time of irradiation. Narrower sectors of mutated colour with a higher frequency were observed at advanced stages of flower development; wider sectors of mutated colour with a lower frequency were induced at vegetative and younger stages of flower development. The number of mutations decreased as greater time elapsed between irradiation and flowering but the frequency of mutant sectors of larger size increased. Various types of physiological injuries were observed. The most commonly observed morphological abnormality was the dissection of ray florets. Mutation rate was very low after chronic γ-irradiation as compared with the acute X-irradiation. (auth)

30802 EFFECT OF IONIZING RADIATION ON MEGASPOROGENESIS IN PINUS RIGIDA MILL. Mergen, F. (Yale Univ., New Haven. Brookhaven National Lab., Upton, N. Y.); Simpson, B. A. Radiat. Bot., 7: 247-52 (June 1967). (BNL-10851).

Periodic collections of 1-yr-old pistillate cones were made from four Pinus rigida trees in the Ecology Forest and from several trees in the Control Forest at Brookhaven National Laboratory. The experimental trees were growing in a natural pine–oak forest that was irradiated by a ^{137}Cs (9500 Ci) source. The forest was exposed to γ-rays during 20 hr each day. In excess of 1000 ovules were dissected from cones exposed to radiation levels of 1.15, 2.15, 2.80 and 3.15 R/20-hr day. Serial microtome sections were used to determine the effect of radiation on fertilization. Fertilization was delayed by chronic γ-exposure, this delay amounting to about 7 days when the controls were compared to the trees at the highest exposure level 3.15 R/20-hr day. In addition, chromosomal aberrations were also observed in several cells during mitosis. Chromosomal bridging was observed at anaphase in cells from nucellar tissue of a cone exposed to 2.80 R/20-hr day and micronuclei were present in an ovule which had received 3.15 R/20-hr day. Photomicrographs were made to illustrate embryo sac development at various stages, and the chromosomal aberrations occurring at two levels of radiation. (auth)

30803 ANALYSIS OF AN INDUCED MUTATION REDUCING SEED SETTING IN DURUM WHEAT. Bozzini, A.; Bagnara, D. (CNEN, Rome). Genet. Agr., 19: 209-22(1965).

From seed of durum wheat (cv. Cappelli), treated in 1956 with thermal neutrons, a sphaerococcoid mutation was isolated that is characterized by a very low seed setting. In the M_4 and M_5 selfed sphaerococcoid progenies some variability in seed setting was noticed. For this reason an attempt was made to select plus and minus variants for this character. However selection did not bring about a positive result, showing the genetical basis of this variability to be slight or there to be no genetic basis at all. A testcross of the mutant line to the mother line (Cappelli), together with data obtained from some natural cross-fertilization, indicated independence between the sphaerococcoid and the low seed setting factor(s). All possible combinations were obtained, segregation following the expected pattern for two independent recessive factors. Analyses of PMC meiosis and of pollen fertility did not show any cytological aberration. Several hypotheses may be advanced to explain the action of the seed setting reducing factor; the most probable seem to be: an interference with the ontogenesis of the macrosporophyte; an inhibition of the fertilization process; or an early degeneration of the embryo or of the endosperm. (auth)

30804 COMPARATIVE MUTAGENIC EFFICIENCY OF ULTRAVIOLET IRRADIATION WITH DIFFERENT WAVELENGTHS. Antoshechkin, A. G.; Shapiro, N. I. Dokl. Akad. Nauk SSSR, 172: 461-3(Jan. 11, 1967). (In Russian).

The general roles of nucleic acid and nucleoprotein injuries in uv radiation induced chromosome aberrations were investigated in experiments on Chinese hamster fibroblastoid cells. Uv wavelengths of 260 and 284 mμ that were selected on the basis of literature data indicated that the maximum absorption spectrum of nucleic acids corresponded to 260 mμ and the maximum absorption spectrum of nucleoproteins corresponded to 284 mμ. Before comparing the relative efficiency of the two wavelengths it was established that duration of mitotic phases was the same for both wavelengths at a given dose. In four experimental series using 40, 50, 60, and 70 ergs/mm^2 doses, the cells were irradiated during the highly sensitive S-G_1 phase. Chromosome aberrations were determined in the metaphase and anaphase stages by an H_3-thymidine autoradiographic method. Findings showed that the 284-mμ wavelength was approximately 35% more effective in its mutagenic effect than the 260 mμ wavelength; this was even higher in the case of small doses (40 ergs/mm^2). It was concluded that the mutagenic efficiency of uv radiation corresponded to the nucleoprotein absorption spectrum and not to the nucleic acid absorption spectrum. These data concurred with literature studies that showed that chromosome aberrations in animal cells can be induced by pyromycin, a protein-synthesis inhibitor. (ATD)

Health Physics and Safety

Refer also to abstracts 30351, 30666, 30668, 30670, 30671, 30838, 30995, 31475, 31663, and 31955.

30805 (AD-638920) A SPACEFLIGHT EXPERIMENT TO ASSESS RADIATION SHIELDING CALCULATIONS. Final Report, 1963-October 1965. Coop, William H.; Chapman, Mac C. (Northrop Space Labs., Hawthorne, Calif.). Apr. 1966. Contract AF 33(657)-11010. 88p. (AMRL-TR-66-34). CFSTI $3.00 cy, $0.65 mn.

The design, development, and testing of a spaceflight experiment to provide data for the assessment of mathematical shielding study models was investigated. The experiment was to provide data for assessment of mathematical shielding study models for comparison with the results obtained by a computer program. This experiment measured proton depth-dose distribution, bremsstrahlung production, and the effects of radiation anisotropy, energy spectrum, and vehicle heterogeneity under known (measured) conditions of radiation environment and vehicle geometry. The experiment instrumentation included sensors for measurement of proton and electron fluxes and spectra and sensors to measure dosage under various shielding thicknesses of aluminum. An instrument to measure x-ray bremsstrahlung from incident electron flux was also provided. The instrument design features are discussed and methods of operation described. (auth)

30806 (HASL-187) TABULATED VALUES OF EXPERIMENTALLY DETERMINED DIFFERENTIAL ENERGY AND ANGLE SPECTRA FOR ^{137}Cs GAMMA RAYS IN WATER AND AIR. Alberg, Mary; Beck, Harold; O'Brien, Keran; McLaughlin, James E. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Dec. 1966. 78p. Dep. CFSTI.

In the 1967 Nuclear Science and Engineering article, "An Investigation of Differential Energy and Angle Spectra for ^{137}Cs Gamma Rays in Water and Air," the measurements and analyses leading to the γ-ray energy and angle spectra in water and a condensed air-like medium were described. Tabulated values of these spectra at the angles and penetration distances that were studied are presented. Also included are the differential energy spectra that were obtained by an integration of the results over all angles, and interpolations of the water spectra that were used for comparison with the spectra obtained in the air-like medium, a 6.15% solution of NaOH. (auth)

30807 (NUMEC-3731-5,3-2) RADIOISOTOPE-POWERED CARDIAC PACEMAKER. SAFETY ANALYSIS: PRELIMINARY DOSE RATE EVALUATION. Caldwell, Roger D. (Nuclear Materials and Equipment Corp., Appolo, Pa. Energy Conversion Div.). Sept. 30, 1966. Contract AT(30-1)-3731. 27p. Dep. CFSTI.

A cardiac pacemaker is described that was designed to be inserted into the patient's body and is powered by a thermoelectric generator that consists of triply-encapsulated ^{238}Pu metal with base-metal quartz thermocouple tapes wrapped around it. The pacemaker electronics and electrode attachment are integrated into the generator case. A sebematic sketch is included. Because ^{238}Pu in the form and purity available emits γ and neutron radiators and the pacemaker is in intimate contact with tissue, the magnitude and possible effects of the radiations were evaluated. The general approach to estimating the dose to tissues surrounding the pacemaker included determination of the source intensity and spectra for neutron and γ radiations; calculation of the radiation flux at points of interest, taking into account the shielding effect of the pacemaker materials and surrounding tissues; conversion of the calculated flux to dose rate; calculation of the decrease in dose rate with depths in tissue; and calculation of the increase in γ dose rate with time resulting from the activity of ^{236}Pu daughters. Preliminary measurements of radiation dose made at the contact points closest to the source are reported. The dose rates calculated were only slightly higher than anticipated. Procedures, dosimeters, and constants and conversion factors used to calculate both internal and external doses are discussed. (C.H.)

30808 (ORNL-4113) RADIATION DOSIMETRY STUDIES AT THE HEALTH PHYSICS RESEARCH REACTOR. Johnson, D. R.; Poston, J. W. (Oak Ridge National Lab., Tenn.). June 1967. Contract W-7405-eng-26. 70p. Dep. CFSTI.

The dosimetric aspects of the Health Physics Research Reactor (HPRR) were carefully investigated and are reported. Studies of parameters such as quantity and symmetry of neutron leakage from the reactor core were included in the work which was done primarily to obtain neutron and gamma-ray air-dose curves as a function of distance. These curves are used both for selecting reactor power levels and exposure times to obtain predesignated radiation exposures and, together with a dependable and reproducible normalization channel, to provide quantitative dose information with an estimated accuracy of ±10%. The fast neutron leakage from the HPRR is 1.3 neutrons per fission. The first collision neutron dose rate at a distance of 2 m with reactor and detector heights of 2 m, is 3.3 ± 0.13 mrad/unit activation of the normalization sulfur pellet. For this reasonable good experimental geometry (H/D = 1), the scattered-to-total neutron dose ratio is 21%, and the neutron-to-gamma-ray dose ratio is approximately 7:1. Summaries are included of typical dosimetry studies on animals exposed to neutrons and γ radiation from the HPRR, dosimetry studies of the environment adjacent to the reactors, and shielding studies. (18 references.) (C.H.)

30809 (SC-DC-67-1854) METHODS OF ASSESSING THE LUNG DOSE FROM INHALED $^{238}PuO_2$. Holley, W. L.; McKelvey, J. W.; Everett, R. J. (Sandia Corp., Albuquerque, N. Mex.). June 1967. Contract AT(29-1)-789. 21p. (CONF-670610-3). Dep. CFSTI.

From 12th Annual Meeting of the Health Physics Society, Washington, D. C.

Plutonium-238 is a prime fuel for space electric power, having been used in the SNAP-9A system, and is the candidate fuel for SNAP-19 and SNAP-27 in the oxide form. The fuel is made in the form of microspheres (50 to 250 μ) designed to eliminate inhalation hazards. However, there are thermo and aerodynamic forces present in launch and re-entry situations that may break up or vaporize this fuel to inhalable sizes. This study is concerned with the methods of assessing lung doses from inhaled plutonium-238 dioxide. Methods of approach are examined and a discussion of these doses is made in relation to the biological effects observed. A model is given which considers the alpha particle energy loss with increasing size and the dose rate to a tissue sphere corresponding to the attenuated alpha range. The present ICRP uniform dose concept is also shown and some comparisons made between the two methods. (auth)

30810 RADIOLOGICAL HEALTH ASPECTS OF OIL WELL LOGGING. Geiger, Norman (Dept. of Health, Education, and Welfare, Charlottesville, Va.); Moore, Raymond T. Public Health Rep. (U.S.), 81: 1064-70(Dec. 1966).

The size of the sources used, the nature of the isotopes, and the conditions under which they are used are factors that must be considered in making a radiation survey of field practices employed by a logging company. Radium-beryllium neutron sources are potentially more hazardous than plutonium-beryllium sources; however, radiation exposure can easily exceed the maximum permissible dose to workmen if precautions are not carefully followed. Since relatively large sources of radium and byproduct materials are used under field conditions widespread contamination could result from an accident, and emergency procedures as well as normal operating procedures should be established by the logging companies. (auth)

30811 SURVEY OF MEDICAL RADIUM FACILITIES IN MINNESOTA IN 1965. Evavold, E. R. (Minnesota Dept. of Health, Minneapolis). Public Health Rep. (U.S.), 81: 1071-4(Dec. 1966).

A preliminary survey indicated the need for a comprehensive survey incorporating a leak test. After adopting a suitable leak-test method, 19 with a combined radium inventory of 1,552 milli-

grams were surveyed. Alpha contamination was found in 15 facilities; some required extensive decontamination. Leaking sources were found in 7 facilities. The protection of personnel from exposure to external radiation was usually found to be inadequate. The surveys demonstrated that most users of radium lack the knowledge and even a basic concern for the hazards of radium usage. (auth)

30812 DOSIMETRIC PROBLEMS IN GYNECOLOGICAL RADIUM IMPLANTS. Schwarz, R. (Univ., Rostock, Ger.). Radiobiol. Radiotherap., 7: 569-72(1966). (In German).

The need for frequent dosimetry when Ra implants are used for the treatment of gynecological neoplasms is discussed. It is pointed out that the γ dose is determined by the possible exposure of adjacent healthy tissues rather than the dose to the tumor. Favorable results using Ra implants for the treatment of 1600 cases are reported. (C.H.)

30813 PROBLEMS OF RADIATION PROTECTION IN NUCLEAR MEDICAL DEPARTMENTS. von Stromberg, G. (Siemens-Reiniger-Werke AG, Erlangen, Ger.). Radiobiol. Radiotherap., 7: 603-9(1966). (In German).

The radiation protection program determines to a great extent the capacity and working possibilities of a nuclear medical department. The expense of radiation protection is very different for the working areas of diagnostics, therapy with unsealed substances, therapy with sealed substances, research, and instruction. Two basic requirements have to be fulfilled. A very good operational procedure should be guaranteed by a correct arrangement of rooms and working areas. The hot part of the laboratory should be entered through sluices. The radiation shielding should be suitable and meet the requirements of personal protection for occupationally exposed persons and for the general population. Waste water, solid waste, and exhaust air must be monitored before disposal and all precautions must be taken to avoid contamination of the environment both inside and outside the building. (C.H.)

30814 CHRONOLOGY OF TWO WEEKS' FALLOUT SHELTER CONFINEMENT. Hammes, John A.; Ahearn, Thomas R.; Keith, James F. Jr. (Univ. of Georgia, Athens). J. Clin. Psychol., 21: 452-6(Oct. 1965).

A day-by-day account is given of a simulated fallout shelter study for the Office of Civil Defense. Previous fallout shelter occupancy research has mainly involved the use of healthy men in the military service, or civilians under conditions of relative comfort. The studies described, in contrast, surpassed in austerity all previous shelter research using civilians. The primary research mission was to appraise minimal survival conditions in public fallout shelters as presently equipped and stocked with emergency supplies. Specifically, the project was to evaluate the interactive effects of such variables as overloading, limited bunks and bedding, emergency sanitation equipment, marginal ventilation conditions, and minimal food and water supplies. Thirty shelterees, 15 males, 15 females, aged 7-66, participated in a 2-week test. Stress conditions included 8 ft^2/person of living space, and rations consisting of 1 qt/person/day of water and 900 cal/person/day of survival biscuits. Shelterees slept on a concrete floor covered only with $^3/_{16}$-in. corrugated fiberboard. A chemical commode was provided. There were no bunks, no blankets, and no water for bathing. No evidence was found to indicate deleterious psychological or physiological effects as a result of the confinement test. (BBB)

30815 ^{226}Ra CONCENTRATION IN MILK IN FRANCE. Michon, G.; De Dreuille, M. Lait, 46: No. 451-2, 33-9(Jan.-Feb. 1966). (In French).

The concentration of Ra-226 in two types of milk was determined. The first type was of mixed milks of wide origin. The second type was milk from small, well designated herds. Results showed a very rigid relation between Ra concentration in the milk and the nature of the subsoil. In regions with sedimentary terrain, only traces of Ra were observed; in regions with terrains of primary origin, the Ra concentration, although variable, was much higher. (J.S.R.)

30816 RADIATION HAZARD TO MAN FROM SOLAR PROTON EVENTS. Snyder, Joseph W. (Manned Spacecraft Center, Houston, Tex.). J. Spacecraft Rockets, 4: 826-8(June 1967).

The dose to man in interplanetary space from solar proton events was studied with dose per event (which combines the effect of flux and spectrum) and event frequency as variables, and with shield thickness as a parameter. Data from 54 significant events in 1956 to 1961 were used in statistical analyses leading to predictions of dose for various periods of time and for various missions. (R.E.U.)

30817 ANIMAL'S NATURAL RADIOACTIVITY IS A MEASURE OF MEATINESS. Smith, G. S.; Lohman, T. G.; Twardock, A. R.; Breidenstein, B. C. Ill. Res., 7: 6-7(Winter 1965).

An instrument designed for whole-body counting of γ radioactivity from ^{40}K in steers is described. The instrument was used to determine whether or not the natural radioactivity of a bovine was an accurate measure of meatiness or fat-free lean tissue (FFLT). The estimation of FFLT was carried out by measuring the γ radioactivity from ^{40}K in the body, calculating from the ^{40}K the total K in the body, and then calculating the FFLT in which the potassium was contained. Results from calculated estimates were compared to results obtained by slaughter of the animals. Experimental results demonstrated that animal and instrument variations could be suitably minimized and that the instrument provided a highly efficient and rapid means of estimating FFLT in either the carcass or the living animal. (B.H.S.)

30818 ^{40}K CONTENT IN KAZAKHSTAN SOILS AND THE RESULTING DOSES OF ATMOSPHERIC RADIATION. Kim, G. G.; Aidarkhanov, B. A. Izv. Akad. Nauk Kaz. SSR, Ser. Biol. Nauk, 4: No. 1, 87-9(1966). (In Russian).

The radioactivity of soil from the Kazakh S.S.R. was determined by flame photometry. The number of soil samples analyzed was 1190. Radioactivity in the soil samples from the southern areas of the region was somewhat less than that in samples from the northern areas. A maximum average of 2.4×10^{-8} Ci/kg, an intermediate average of 2.0×10^{-8} Ci/kg, and a minimum average of 1.1×10^{-8} Ci/kg in black soils, chestnut soils, and salt soils, respectively, was found. The γ radiation doses that resulted from the the ^{40}K content in the soil were calculated; values varied from 16.5 to 24.6 mrads/year in salt soil areas to 25.98 to 36.2 mrads/year in black soil areas. (B.H.S.)

30819 THE CONTENT OF LONG-LIFE FISSION PRODUCTS IN THE WATER OF THE MOSCOW PIPED WATER SUPPLY. Golutvina, M. M.; Kazakova, T. A. Gig. Sanit., No. 10, 111-12 (Oct. 1966). (In Russian).

The concentration of ^{90}Sr in the water supply of Moscow was about 1.6×10^{-2} Ci/l during 1964. The yearly concentration of ^{137}Cs was 1.5×10^{-13} Ci/l. The maximum concentration of ^{90}Sr and ^{137}Cs isotopes during the month of March 1964, exceeded the annual mean average about 3 fold. These mean annual average concentrations were 20 and 7000 times below the permissible dose. (R.V.J.)

30820 ON THE METHOD OF DETERMINING ^{90}Sr IN PLANTS. Zatsepina, L. N.; Saparlyev, Ch.; Pavlotskaya, F. I. Gig. Sanit., No. 10, 68-70(Oct. 1966). (In Russian).

An analysis of ash of various grasses was carried out by precipitation of ^{90}Sr and Ca oxalates and by a simpler method that did not require precipitation of the oxalates. The radiochemical purity of the extracted ^{90}Sr was verified by the half-life decay curve. The results of determination of ^{90}Sr in Lolium rigidum, Carex physodes, and Poa bulbosa by the simplified method are presented in tabular form. The procedures used in the simplified method are outlined. It was shown that the method was quite effective on specimens without the presence of fresh fission products: i.e., specimens selected after 4 or more months following fallout deposition. (R.V.J.)

30821 BASIC PRINCIPLES FOR RADIATION PROTECTION IN THE USE OF RADIOACTIVE MATERIALS IN MEDICAL AREAS. Schriftenreihe Bundesmin. Wiss. Forsch., Strahlenschutz (Munich), No. 29, 1-35(1966). (In German).

The basic principles of radiation protection are outlined with respect to the doctor and the patient and for those coming in contact with people working with or being treated with radioactive materials. (J.S.R.)

30822 FILM DOSIMETRY OF ^{60}Co BEAM RADIATIONS. Tsunemoto, Hiroshi (National Inst. of Radiological Sciences, Chiba, Japan); Kusumoto, Goro. Nippon Igaku Hoshasen Gakkai Zasshi, 26: 876-81(Oct. 1966). (In Japanese).

The measurements of the isodose curves utilizing exposed film are useful in planning radiation therapy. This can be obtained from iso-density curves of the film exposed to ^{60}Co beam radiations. In order to obtain the accurate isodose curves from film dosimetry, films with linear characteristic curves need to be used. The direct linear conversion from film response to exposure should be considered to be particularly important when films are scanned and the data transcribed automatically on a recorder. Three types of films were used, including Fuji Industrial Type 80, Sakura Industrial Type R, and Kodak Industrial Type M, and the linear responses between film density and exposure dose were measured by placing a film between Mix-D phantoms or Acrylite phantoms exposed to ^{60}Co beam radiations in either fixed or moving field conditions. Comparison of the differences in dose distri-

bution between film dosimetry and ionization chamber was made. In the fixed exposures, the differences of the two methods became larger when wider fields were used. This became lesser by using thinner phantoms. In this experiment, 25 mm thick phantoms were most adequate for the above purpose. In the moving field exposures, most of the dose distributions measured by the films and by the ionization chamber showed coincidence. The isodose curves of the ^{60}Co beam radiations can be measured by film with more accuracy if one considers the facts mentioned above. Combination of the isodose plotter and photodensitometer is clinically convenient, as the curves can be recorded automatically by utilizing the exposed films. (NSA of Japan)

30823 RADIATION PROTECTION. RECOMMENDATIONS OF THE INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION. Report of Committee V on the Handling and Disposal of Radioactive Materials in Hospitals and Medical Research Establishments (1964). ICRP Publication 5. New York, Pergamon Press, 1965. 55p.

Recommendations of the International Commission on Radiological Protection for the handling and disposal of radioactive materials in hospitals and medical research establishments are presented. Topics discussed include the design of laboratories, isotope clinics, wards, and operating rooms where radioactive materials are used; personnel and environmental monitoring in areas where sealed and unsealed radiation sources are used; maximum permissible concentration values for various radionuclides in air; working procedures and contamination control; the decontamination of clothing, buildings, and equipment; the decontamination of personnel; the disposal of radioactive waste; the transportation and storage of radioactive materials; the discharge of patients during treatment with radioactive materials; and the handling of radioactive cadavers. (C.H.)

30824 APPARATUS FOR THE APPROXIMATE DETERMINATION OF THE LEVELS OF CONTAMINATION OF CLOTHING OR OTHER ARTICLES BY COUNTING OF ALPHA AND BETA PARTICLES. Fleury, Jacques (to European Atomic Energy Community (EURATOM)). British Patent 1,060,835. Mar. 15, 1967. Priority date Apr. 11, 1963, Belgium.

An instrument is described that was designed for the radiation monitoring of contaminated clothing by counting α and β particles. The instrument uses a gas flow proportional detector with anticoincidence channel and discriminators. The instrument may be used as an automatic sorter for contaminated clothing. (C.H.)

30825 LOW RADIATION LEVEL CHAMBER. Poulheim, Karl Friedrich; Niesler, Herbert; Hoesselbarth, Harri (to Zentralinstitut fuer Kernforschung). British Patent 1,073,716. June 28, 1967. Filed June 19, 1964.

A low level radiation chamber (whole-body counter) which is constructed of shielding material containing gypsum of low radioactivity ($\leq 10^{-8}$ to 10^{-9} μCi/g) is described. (B.G.D.)

Medicine

Refer also to abstracts 30812, 30913, and 30918.

30826 (COO-1653-28) SELECTIVE ISOTOPIC LABELING OF THE PARATHYROID GLAND. Progress Report, September 1966–June 1967. Potchen, E. James (Washington Univ., St. Louis, Mo. Edward Mallinckrodt Inst. of Radiology). Contract AT(11-1)-1642. 21p. Dep. CFSTI.

Progress is reported in attempts to develop a clinically reliable technique for the anatomic identification and functional evaluation of human parathyroid glands. Emphasis was placed on studies of the mechanisms controlling thyroid and parathyroid amino acid acretion. Data are reported from studies on the effects of Ca content in the diet on the uptake of ^{75}Se-selenomethionine by the parathyroid glands of normal rats. Other means of enhancing parathyroid uptake of selenomethionine, including the effects of EDTA, were also investigated. Clinical studies on the localization of parathyroid adenomata with ^{75}Se-selenomethionine and ^{99}Tc-albumin, which remains in the blood stream during the course of the study, are reported. Dual isotope scan measurements with simultaneous recording and printing of separate scans were employed. Programs were written for the IBM 360/50 computer for manipulation of the scan data. Initial experiments show that this may prove to be a useful technique. (27 references.) (C.H.)

30827 (ORNL-P-1858) QUANTIFICATION OF SCAN RECORDS. Harris, C. C. (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 13p. (CONF-651210-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Symposium on Computers and Scanning, New Orleans.

The clinical usefulness of scan information can be greatly enhanced by proper storage of these data for subsequent retrieval and manipulation. The use of computers provides a means of storage, retrieval, and manipulation. Simpler methods are also possible and very useful. The intelligent use of scan information requires the maximum possible use of the quantitative aspect and no means, however simple, should be overlooked. (auth)

30828 SINGLE-SURFACE CUTTING OF NORMAL TOOTH WITH RUBY LASER. Gordon, Thomas E. Jr. J. Amer. Dent. Ass., 74: 398-402(Feb. 1967).

The effect of focused ruby laser radiation (6943 Å) on human teeth was studied in vitro. Tooth material, including enamel and dentin, was removed by abrupt vaporization. The vaporized matter in the plume contains positively and negatively charged particles in the state of a luminous gas. Impact energies of 50 J exit energy per impact were used initially. All impacts were accompanied by a sharp, audible sonic shock. In attempts to develop a cavity preparation with definite outline form, some control of the cutting with respect to floor depth and flatness was achieved, but cone shape sites caused by defects of laser impact only disappeared when the dentinoenamel junction was penetrated. Below the junction, square walls and sharp pulpal line angles were evident. Dentin cutting occurred in regions where the beam did not directly impact. This resulted in pronounced undercutting of the dentin. Deposition of clear fused material with a bubblelike inclusion was noted. The material apparently derives from enamel. A fused tooth structure was uniformly present on the floor of the cavity. (BBB)

30829 POSSIBLE USE OF ^{133}Xe IN CANCER THERAPY. Packer, L. Leonard (United Aircraft Research Labs., East Hartford, Conn.). Nucl. Appl., 3: 360-5(June 1967).

The 31 and 81 keV x- and gamma-ray emissions, curie level specific activity, 5 day half-life, and reasonable cost make ^{133}Xe an attractive source for use in cancer implantation therapy. The qualifications of ^{133}Xe as an implantation source, and an analysis of shielding and absorption characteristics are discussed. A method for source fabrication using liquid nitrogen cryopumping and heat sealing of plastic tubing is described. (auth)

30830 RADIOISOTOPES IN PHARMACY AND MEDICINE. Storey, Robert H.; Zimmermann, Albert J. J. Amer. Pharm. Ass., 7: 140-4(Mar. 1967).

The development, production, detection, and safe handling of radiopharmaceuticals are reviewed, with 24 references. Although the medical use of radiopharmaceuticals encompasses both diagnostic and therapeutic applications, the most widespread use is in diagnosis because the radioisotope method is sensitive and specific. Iodine-131 was one of the first isotopes used medically, and continues to have the greatest utility, accounting for 75% of all medical uses of radiopharmaceuticals. The use of ^{32}P, ^{131}I, ^{198}Au, ^{51}Cr, ^{99m}Tc, and other radioisotopes for various diagnostic and/or therapeutic purposes is described, and precautions attendant with their use are described. Penetration power in tissues and other substances of various radiations emitted by different radioisotopes is also considered. Equipment for manufacture of radiopharmaceuticals that ensures safety for the operators is described and illustrated. (BBB)

30831 THE ROUTINE USE OF GRID IRRADIATION IN OPERATED AND NOT OPERATED CERVICAL CARCINOMA. Jaeger, W. (Bezirkskrankenhauses, Cottbus, Ger.). Radiobiol. Radiotherap., 7: 525-8(1966). (In German).

Routine x irradiation of patients with cervical carcinoma under grid conditions is not recommended. It is suggested that this technique should be used only for advanced cases until results of further investigations are available. (C.H.)

30832 INDICATIONS AND EARLY RESULTS OF INTRAVAGINAL X-RAY DEPTH THERAPY. Stratev, I. (Wissenschaftliche Institut fuer Geschwulstforschung, Sofia). Radiobiol. Radiotherap., 7: 529-31(1966). (In German).

Intravaginal depth x ray therapy in about 5 to 10 percent of combinatedly treated patients with carcinoma of the cervix is indicated in the case of a recidivation or in parametrial residual infiltrates. Early results using this technique were good. (C.H.)

30833 COLPOSCOPIC STUDIES DURING IRRADIATION OF CERVICAL CARCINOMA. Rieck, G. (Humboldt-Univ., Berlin). Radiobiol. Radiotherap., 7: 533-55(1966). (In German).

The colposcopic and histological changes before, during, and after x irradiation were studied and evaluated on about 100 cervical carcinomas of stage 1 that had been preirradiated with an intracavitary tube and then operated. The possibilities for drawing prognostic conclusions by means of cytology and histology are discussed and the value of colposcopic examinations for the early recognition of irradiation sensibility is tested. The pictures under irradiation which differ from the usual colposcopic nomenclature are described. The tissue samples obtained during operation were histologically examined in step sections and the results compared

with the former colposcopic findings. It was concluded that colposcopy during fractionated irradiation may give valuable information on the responsiveness of a carcinoma. (auth)

30834 OUR EXPERIENCES WITH TELECOBALT THERAPY OF PARAMETRIAL RECIDIVATIONS OF TUMORS OF THE UTERUS. Karpati, Georg; Gonda, T.; Ravasz, L. (Institut fuer Onkoradiologie, Budapest). Radiobiol. Radiotherap., 7: 557-63 (1966). (In German).

Examination of data on results of γ teletherapy in patients suffering from carcinoma of the uterus led to the conclusion that treatment of the primary tumor is of decisive importance. This relates first of all to the operation which should be performed on the basis of a correct indication but also to the preoperative and postoperative radiation therapy. As to the patients being exclusively treated by radiation therapy the use of modern radiation sources and administration of the optimum dose annihilating the tumor are very important. In order to prevent parametrial recidivations or abdominal hysterectomy seems to be more favorable than the vaginal one. Parametrial recidivations more frequently occur due to tumors with immature cells than due to tumors with differentiated mature cells. In young patients with carcinoma of the uterus parametrial recidivations occur more frequently than in old patients. Corpus tumors more rarely (15.3 percent) lead to parametrial recidivations than cervical tumors (84.7 percent). The use of ultrahard radiation sources (telecobalt therapy) in the treatment of parametrial recidivations of tumors of the uterus is a progress compared with the former use of radiation. (auth)

30835 THE TREATMENT OF ACUTE INTESTINAL RADIATION REACTIONS IN TELECOBALT AND RADIUM IRRADIATIONS. Neumeister, K.; Pfeiffer, J.; Zamecnik, J. (Karl-Marx-Univ., Leipzig. Onkologische Institut, Prague). Radiobiol. Radiotherap., 7: 565-8(1966). (In German).

The treatment of acute intestinal radiation reactions induced by telecobalt and radium irradiations by means of prophylactic administration of coli-dragees and pancreatic ferments from the first day of irradiation is reported. The frequency of intestinal disturbances following abdominal irradiations was decreased by this treatment from 78.4 percent (controls) to 20.6 percent (Leipzig Clinic) and from 46.7 percent to 6.6 percent (Prague Clinic) respectively. (auth)

30836 MASSIVE GRID IRRADIATION OF GYNECOLOGICAL TUMORS. Rode, I.; Hajdu, I. (Staatliche Onkologische Institutes, Budapest). Radiobiol. Radiotherap., 7: 521-4(1966). (In German).

Massive x radiation grid irradiation was used for the treatment of 106 malignant gynecological tumors. The massive radiation doses were well tolerated by the patients, no radiation injuries were observed, and local and general reactions were milder when conventional irradiation methods were used. The therapeutic results were at least equal to those obtained by conventional irradiation method. (C.H.)

30837 PROTECTION THROUGH PARABIOSIS AGAINST THE LETHAL EFFECTS OF EXPOSURE TO LARGE DOSES OF X RAYS. Carroll, Harold W.; Kimeldorf, Donald J. (Naval Radiological Defense Lab., San Francisco). Science, 156: 954-5 (May 19, 1967).

Parabiotic rat pairs with a skin-vascular anastomosis were used to test whether shielding of one member of the pair would protect the irradiated partner against exposure to very large doses of x rays (1200 to 2400 R). Except with the lowest dose, all unshielded-irradiated pairs or single irradiated animals died before 5 days had elapsed. In contrast, irradiated rats that had a shielded parabiont partner survived the 5-day period and many survived beyond 30 days. This was interpreted as protection against the acute intestinal death that normally occurs in the dose range investigated. (auth)

30838 DOSE DISTRIBUTION AND ADVANTAGES IN IMPLANTATIONS WITH IRREGULARLY LOADED ^{60}Co NEEDLES. Sachatchiev, A.; Pentschev, P. (Onkologische Forschungsinstitut, Sofia). Radiobiol. Radiotherap., 7: 573-9(1966). (In German).

The γ dose distribution in the area of ^{60}Co needles with higher linear activity at one or both ends of the needles is demonstrated by means of equidensitometry. The implantation of such needles in palisade-shaped arrangement gives a good dose distribution in the area of implantation and facilitates the puncture at regions that are difficult to reach. The extent of radiosurgical interventions and expense of time is decreased and thereby radiation exposure of the staff is reduced, too. Simultaneously, a good distribution of the needles within the tissues will be obtained and an eventual reconstruction of the implants will be possible. The implantations performed with the new method since 1963 did not yield essential differences in the course of the radiobiological reaction and in the results of recovery compared with former ones. (auth)

30839 EXAMINATIONS WITH ^{85}Sr IN BONE-TUMORS. Kolar, J.; Janko, L.; Bek, V.; Vyhnanek, L.; Babicky, A. (Charles Univ., Prague. Central Isotope Lab., Prague). Radiobiol. Radiotherap., 7: 581-6(1966). (In German).

Results of 82 examinations of 76 oncological patients by means of the diagnostic ^{85}Sr test are briefly discussed. Positive findings were obtained before a positive roentgenological result in osteolytic as well as in osteoplastic primary and secondary bone-foci. The radiation exposure was within the permissible limits. The test may be performed with a relatively simple arrangement so that it is recommended for a wider use. (auth)

30840 GAMMA ENCEPHALOGRAPHY WITH RADIOACTIVE ^{206}Bi. van der Werff, J. Th. (St. Canisius Ziekenhuis, Nijmegen, Netherlands). Acta Radiol., Diagn., 4: 403-16(July 1966).

A new method of γ encephalography using the pure γ emitter ^{206}Bi is described and results obtained in 216 cases are reported. The concentration of ^{206}Bi in brain tumors followed immediately after that in the kidney, spleen, and liver. The enrichment quotient in tumors attained a value of 75 to 100, as compared to normal brain tissue, between half a day and two days after the intravenous injection of carrier-free ^{206}Bi nitrate. The biologic half-life in the tumor was between 6.4 and 7.2 days, and thus considerably longer than that of ^{131}I-labeled serum albumin. It was found that glioblastomas and undifferentiated gliomas have a high accumulation factor, whereas astrocytomas exhibit a lower accumulation factor. Meningiomas had a low-to-medium accumulation factor, and carcinomatous metastases a low accumulation factor. In earlier tests ^{206}Bi nitrate was used, but no difference was found in the results with other inorganic compounds of ^{206}Bi. An intravenous injection of 0.3 mCi carrier-free ^{206}Bi acetate was generally given, and measurements carried out 12 to 24 hr later. It was shown that ^{131}I-serum albumin gives a γ encephalogram very similar to the one obtained with ^{206}Bi. The same positive peaks were evident; yet the 2 encephalograms were not identical, probably on account of the different energies of the radiations emitted by the 2 isotopes. The ^{206}Bi has some advantages over ^{131}I: the strong affinity of ^{206}Bi for the different tumors with a definite and long-lasting accumulation in the tumor cells; the low radiotoxicity of ^{206}Bi($\frac{1}{20}$ that of ^{131}I), mainly due to the absence of β radiation; and less hazard to the thyroid. (BBB)

30841 BASIC PRINCIPLES AND INDICATIONS FOR THE HARD-RAY TECHNIC. Kroeger, W. (Medizinische Universitaetsklinik, Rostock, Ger.). Deut. Gesundheitsw., 20: 1187-90(June 30, 1965). (In German).

Reasons for the use of relatively high-energy x rays (~120 kv) for radiodiagnosis are explained and their use recommended over that of soft, unfiltered x rays, mainly because of the radioprotection features offered. The hard-ray technic offers the following main advantages: the size of the demonstrable object is increased, the focussing sharpness is improved due to a shortened exposure time, the somatic x-ray exposure of the patient is decreased, and the gonad dose involved in x-ray photos in the vicinity of the gonads is reduced. The simultaneous reduction of the tube load enables a considerable increase of the frame frequency for rapid serial photos. The application of the hard-ray technic is mainly indicated for thorax photos. Also described are the characteristic features and advantages of these photos. The use of hard, filtered x rays is particularly important in radiodiagnosis in pregnant women, both the genetic and somatic dose being reduced by the removal of soft rays which are absorbed by sensitive tissues without contributing to the radiographic image. The technic also favors increased contrast between bone and soft tissue and between soft tissue and air spaces (such as in the lungs). (BBB)

30842 ON THE MODIFICATION OF THE RADIATION SENSITIVITY OF MAMMALS BY CHEMICAL SUBSTANCES. Melching, H. J.; Streffer, C. (Univ., Freiburg i. B.). Progr. Drug Res., 9: 11-128(1966). (In German).

The authors first review effects of radioprotective chemicals containing sulfhydryl groups. These include cysteine, cysteine derivatives, homocysteine, methionine, glutathione, cysteamine, cysteamine derivatives, aminoethylisothiuronium salts and mercaptoethyl guanidine and their salts. The effects of other radioprotective chemicals are also reviewed. These include alkaloids and biogenic amines such as serotonin and its derivatives, histamine, adrenalin, and noradrenalin. Effects of each class of radioprotective chemicals on survival rate, radiogenic alterations in organs, cell cultures, biochemical systems, radioinduced metabolic changes, protective effects, and increased resistance to radiation are evaluated. The mechanisms of effect of radioprotective chemicals are discussed. These include physicochemical hypotheses, pharmacodynamic considerations, the biochemical

processes involved, and radioinduced changes in the body concentrations of substances that contain sulfhydryl groups, serotonin, histamine, adrenalin, and noradrenalin. Additional biochemical bases of the mechanism of effect to produce a radioprotective effect are discussed. References cited, 515. (BBB)

30843 DENTAL ASPECTS OF THE PROBLEMS, CARE, AND TREATMENT OF THE IRRADIATED ORAL CANCER PATIENT. Rahn, Arthur O. (Univ. of Kentucky, Lexington); Drone, Joe B. J. Amer. Dent. Ass., 74: 957-66(Apr. 1967).

Prevention, treatment, and incidence of radioinduced complications of oral cancer radiotherapy are commented upon, with reference to 3 patients in which such complications resulted. In the preirradiation stage, the dentist can play an initial prominent role in the care of the patient. The removal of teeth before radiotherapy is controversial. Some believe that only decayed teeth and teeth in the path of the x-ray beam should be extracted. Others believe in leaving all the teeth in the mouth, and some suggest the extraction of all remaining teeth. In the 3 patients described who received radiotherapy and in whom teeth had been left in place, necrosis developed in the regions of the teeth that remained in the field of radiation. The time of onset varied from a few months to 10 yr. As long as any teeth remain in the field of irradiation, there is always a chance of complication that may result in a serious dental management problem. Deeply carious teeth in which there is a possibility of exposing the pulp should always be removed before irradiation. Such extractions should be done with the least possible trauma, thereby avoiding unnecessary tissue damage with its consequent slow healing that would delay radiotherapy. Fluoride treatment of the teeth should be started and should be continued every day during x-ray treatment. The chief complaint of patients during radiation treatment, particularly if the salivary glands are in the field of irradiation, is xerostomia. The condition may be so pronounced that the patient has difficulty in speaking and swallowing. A mouthwash should be used to keep the oral tissues lubricated. The role of the dentist in caring for the 3 primary complications after radiotherapy to the head and neck (trismus, decay of remaining teeth, and necrosis) is outlined. (BBB)

30844 MEASUREMENT OF RADIOACTIVELY LABELED TISSUE SECTIONS. Anton, Hermann Josef (Univ., Cologne). Histochemie, 8: 19-21(1967). (In German).

Comparisons of measurements of ^{3}H activity in histological sections of the axolotl femur were made after 3 methods of preparation. Efficiency of counting of samples dissolved in hyamine was ~⅓ greater than for sections mounted on slides and immersed in liquid scintillator or for sections free floating in scintillator solution. One particular advantage of the preparation of the section on the slide was that the tissue was not destroyed, and also could be used for histological study and autoradiography. The greater the thickness of the section, in the range from 3 to 10 μ the greater was the count rate of the section. The radioactivity of the slide mounted sections was not leached out during sample preparation. The slide method is well suited for preparation of blood samples, cell cultures, and bacteria. (BBB)

30845 PRELIMINARY OBSERVATIONS AND RESULTS WITH THE USE OF HYPERBARIC OXYGEN AND ^{60}Co TELETHERAPY IN THE TREATMENT OF CARCINOMA OF THE CERVIX. Johnson, R. J. R. (Manitoba Cancer Treatment and Research Foundation, Winnipeg). Nat. Cancer Inst. Mongr., No. 24, 83-91(Feb. 1967).

Side-effects and complications of irradiation under high-pressure oxygen in 50 cases of Stage III and IV cervical cancer are reported. All the patients treated under hyperbaric oxygen received a daily fractionation dose similar to that of a control group. Most of the patients received a total dose of over 5750 rad, corresponding to 6000 R previously given. A few patients in both groups received less than 5750 rad due to interruption of the treatment because of diarrhea, skin reaction, or by early death. Diarrhea sufficient to cause a day's rest from treatment occurred in 10% of the control group. The clinical criteria for stopping treatment because of diarrhea did not change for the 2 groups. Reasons for this decreased incidence of diarrhea could not be explained. Possibly the daily hyperbaric oxygen treatment affected the intestinal bacteria or decreased the doubling time of the mucosal cells and thus assisted repair processes. It was thought that the daily tumor dose increment could be increased above 220 rad per day without causing an increased incidence of bowel reaction. Some patients treated with anterior and posterior fields, with a separation over 20 cm, showed subcutaneous fibrosis but this was also observed in the control patients. It did not occur with a 4-field technique. Fracture of the neck of the femur occurred in 1 patient irradiated under hyperbaric conditions with ^{60}Co to a dose of 6000 rad in 6 weeks. Among patients who died within the first 6 months in the hyperbaric group, 25% died with distant metastases, compared with only 5% of the control group. (BBB)

30846 EXPERIMENTAL STUDIES ON THE CORRELATIONSHIP BETWEEN TUMOR BED AND RADIATION THERAPY. Nakatsuka, Haruo; Takeuchi, Tetsuichi (Osaka City Univ.). Nippon Acta Radiol., 8: 999-1006(Nov. 1966). (In Japanese).

Several experimental studies concerning the relationship between the tumor bed and radiation therapy were performed using Ehrlich ascites tumor in mice. After pretransplantation irradiation of the tumor bed the implant of the Ehrlich ascites tumor cells showed delayed onset of palpable tumor nodule and slow growth. The histological examination revealed inability to produce new blood vessels in the tumor and the surrounding connective tissue at the preirradiated tumor bed. The slow growing tumor in the irradiated tumor bed showed increased resistance to the radiation treatment. The localized irradiation of the tissue surrounding the tumor, while the tumor itself was shielded with lead, resulted in slight inhibitory effect on the growth of the implanted tumor. Preirradiation injection of phenylephrine (a vasoconstricting agent) in the tissue surrounding the tumor resulted in the reduced radiosensitivity of the tumor and tumor bed. In view of these experimental results the significance of the tumor bed in radiation treatment of malignant tumors was discussed. (NSA of Japan)

30847 TREATMENT OF SKIN CANCER. Knox, John M.; Freeman, Robert G.; Duncan, W. Christopher; Heaton, Charles L. (Baylor Univ., Houston, Tex.). S. Med. J., 60: 241-6(Mar. 1967).

Use of radiation of various types to treat skin cancer is reviewed with attention to optimal modality and doses, shielding of healthy tissues, contraindications, and complications. When x rays are used a total tissue dose of 4000 to 5000 R with half value layer of 0.6 to 1.0 mm Al usually is administered. Considerable individualization is necessary, though a widely recommended plan is 500 R daily for 8 to 10 treatments. For convenience 1000 R every other day may be employed. The outermost edges of lesions should be carefully defined, and after allowing for a reasonable margin of normal tissue (~5 mm), the adjacent skin shielded with lead. In most instances a special shield should be designed and cut for each lesion. As a general principle, cancericidal radiation therapy should be avoided in young persons because of the long-term sequelae, particularly radiodermatitis, malignancy, and further aggravation of damage to irradiated skin by superimposed exposure to sunlight. In elderly patients irradiation may be more acceptable because of less danger of these late sequelae. Complications of radiotherapy include radiodermatitis, epilation, damage of the oral mucous membrane, osteomyelitis (particularly with irradiation of tissue about diseased teeth), and chondritis and perichondritis of the ear, nose, or nasal septum. Irradiation of the eyes may cause cataracts, occlusion of the tear duct, conjunctivitis or corneal damage. Special irradiation techniques for use of α, β, and γ emitters are described which may be used to deliver high doses to the tumor cells while avoiding overirradiation of sensitive normal tissues. (BBB)

30848 SCINTIGRAPHY OF BONE METASTASES USING ^{85}Sr. Bessler, W. (Kantonsspitals, Winterthur, Switzerland). Fortschr. Geb. Roentgenstr. Nuclearmed., 106: 43-51(1967). (In German).

On 21 patients with bone metastases scintigrams were taken with ^{85}Sr. The increased bone formation which takes place with osteoplastic metastases and the relatively increased reformation of bone in the vicinity of osteolytic metastases results in an enriched deposition of radioactive strontium, which becomes very obvious by scintigraphy. Skeleton scintigraphy is particularly valuable in the early diagnosis, which is not always obtainable by x rays and also to establish particularly active tumour-foci which require urgent irradiation. (auth)

30849 EFFECT OF POST-TREATMENT WITH ERYTHROPOIETIN (S) ON SURVIVAL AND ERYTHROPOIETIC RECOVERY IN IRRADIATED MICE. Naidu, N. V.; Reddi, O. S. (Osmania Univ., Hyderabad, India). Nature, 214: 1223-4(June 17, 1967).

It is stated that the excellent results obtained in the treatment of radiation sickness by the injection of fresh hemopoietic tissue are complicated by the fact that the irradiated animals recover their ability to react against foreign proteins, and this may result in a homograft reaction. Agents have been sought to induce recovery in the bone marrow of irradiated animals. Stimulation of erythropoiesis in sub-lethally irradiated rats by anaemic plasma was presumed to be caused by its erythropoietin content, but hitherto no systematic investigation had been made to test the value of erythropoietins in radiation injury; hence the reason for the investigation described. Bullocks rendered anaemic with phenylhydrazine served as a source of erythropoietins, which were then administered intraperitoneally to mice. Data are given for effect of post-treatment with erythropoietins on the survival and body size of mice exposed to 1,000 R of x-radiation—also on ef-

fect of the post-treatment on the reticulocyte response of mice similarly exposed. Results indicate the significance of the erythron in post-irradiation recovery and survival, and suggest that erythropoietins not only stimulate earlier regeneration of the erythropoietic tissue, but also increase survival of irradiated animals. (UK)

30850 RADIOPROTECTIVE EFFECT OF DIMETHYLSULFOXIDE ON LACTATE DEHYDROGENASE. Lohmann, W. (Univ. of Iowa, Iowa City); Moss, A. J. Jr.; Barker, S. L. Naturwissenschaften, 53: 702(1966).

Rabbit muscle lactate dehydrogenase (LDH) solutions were treated with dimethylsulfoxide (DMSO) in various concentrations, then x irradiated. Activity of LDH was then determined spectrophotometrically as a function of time. It was found that the addition of small amounts of DMSO has considerable protective effect. At high concentrations of DMSO and lower radiation doses, the protective effect is less than that for smaller concentrations. At high radiation doses, protection is proportional to DMSO concentration. It appears that the method of protection arises from a metal-DMSO complex, with the greatest protective effects coming from agents capable of interacting with metal ions present in biological systems. (C.O.)

30851 THE RADIOPROTECTIVE EFFECT OF IMIPRAMINE. Uray, Zoltan; Holan, Tiberiu (Sectia de Medicine Nucleara, Cluj). Naturwissenschaften, 53: 552-3(1966). (In German).

Radioprotective effects of imipramine were investigated in lethally irradiated mice. Mice were given various doses of imipramine before irradiation and compared with untreated irradiated animals. The 30 day survival rate, average survival time, changes in body weight, and general symptoms of radiation syndrome were observed. The tabulated results show that imipramine exerts a radioprotective effect equivalent to that of AET. (H.L.W.)

30852 AN EFFECT OF DMSO ON POST-IRRADIATION SACCHARIN AVOIDANCE IN MICE. LeVan, H.; Moos, W. S. (Univ. of Illinois, Chicago). Experientia, 23: 276-7(Apr. 15, 1967).

Mouse preferences for water over saccharin solution were recorded before and after treatment with 450 R x irradiation. Half the mice were treated with dimethyl sulfoxide (DMSO) just before irradiation. After irradiation a reaction of saccharin avoidance occurred. DMSO treatment lessened that reaction. (C.O.)

30853 EFFICACY OF LINEAR ACCELERATOR X-RAY THERAPY IN CANCER OF THE BLADDER. Caldwell, William L. (Vanderbilt Univ. Hospital, Nashville); Bagshaw, Malcolm A.; Kaplan, Henry S. J. Urol., 97: 294-303(Feb. 1967).

Complications of megavoltage irradiation of bladder carcinoma are reported. All patients received radiotherapy with x rays from either the 5-MeV Stanford medical linear accelerator or the 6-MeV Varian linear accelerator (Clinac). Patients with stages A and B_1 disease ordinarily received a maximum tumor dose of 7000 rad through multiple small fixed fields or through small fields using rotation. Most patients tolerated treatment satisfactorily, with slight to moderate increase in urinary symptoms. Six patients did not complete the planned course of treatment, because of deterioration of general condition. One patient died of a myocardial infarction after receiving a tumor dose of 2000 rad, another of pulmonary edema after 600 rad. The incidence of post-treatment cystitis was 14% for patients surviving one or more years. Those surviving less than one yr frequently had residual bladder cancer and distinction between symptoms secondary to tumor or irradiation was impossible. Symptoms of cystitis persisting for more than a year after radiation were attributed to radiotherapy. Symptoms, including frequency, urgency, nocturia, dysuria, and hematuria, were most significant and frequent in patients with stage A tumors. Three of these patients suffered severe radiation cystitis; one has required a cystectomy. Many patients suffered controllable diarrhea during the last 2 to 3 weeks of irradiation. However, significant diarrhea persisted for more than 3 months postirradiation in only 5 instances; colostomy was required in one of these patients because of persistent bleeding. Two patients with persistent tumors in the bladder had small bowel perforations which eventually resulted in their death. The frequency of postirradiation urinary symptoms was essentially the same regardless of treatment regimen, being perhaps most prevalent in the whole-pelvis technique with supplemental bladder irradiation. With this method, the bladder dose was slightly greater than with the small field technique since the minimum bladder dose was at least 6800 rad for a maximum of 7000 rad. (BBB)

30854 DIAGNOSTICS, CLINICAL PICTURE, AND THERAPY OF ACUTE RADIATION INJURY. Gyenes, Gyoergy. Fiz. Szemle, 17: 73-9(Mar. 1967). (In Hungarian).

Partial or whole-body exposure of persons to radiation results in a clinical picture designated as acute radiation sickness. Onset and gravity of the symptoms depend on the dose, the type of radiation, and the sensitivity of the individuals involved. In some cases, the exposure may not be known for some time. Highest doses result in injury to the nervous system; lower doses primarily affect the gastro-intestinal tract; still lower doses interfere with the blood-forming processes. However, sharp distinction between the latter two cases is often difficult. Determination of the dose and of the γ/neutron ratio is of great help to the attending physician. Appearance of clinical symptoms permits estimation of the dose biologically: if the patient starts regurgitating within a few hours after the exposure, it may be assumed that he was exposed to a dose higher than 200 R; this is serious but not necessarily fatal. Diarrhea within 48 or 72 hours is an indication of a probably lethal dose. On the basis of hematological injury, bone marrow transplantation may be considered. Efficient treatment of radiation injury requires close collaboration of a team that consists of a chemist, health physicist, physician, technician, and others. (TTT)

30855 NEW RADIOPHARMACEUTICAL FOR LIVER SCANNING. Goodwin, D. A. (Johns Hopkins Medical Institutions, Baltimore); Stern, H. S.; Wagner, H. N. Jr.; Kramer, H. H. Nucleonics, 24: No. 11, 65; 68(Nov. 1966).

The use of indium-113 in liver scanning is discussed. Indium-113 is a particularly attractive radionuclide for scanning because it is available from a $^{113}Sn-^{113m}In$ generator. It emits a monoenergetic γ ray with an energy of 390 keV and it has a half-life of only 1.7 hr. The sum properties result in a compound that gives a low radiation dose and has a decreased cost per millicurie scanning dose over the useful life of the generator, together with instant availability. The incorporation of ^{113m}In into a colloid that deposits selectively into the liver is both simple and rapid. Moreover, the gamma emission of the isotope is suitable for detecting and characterizing deep-seated liver lesions using the scanning devices in current use. The biological half-life of 30 days does not result in an excessive radiation dose because of the short physical half-life of the isotope. It is estimated that the radiation dose to the liver is ~0.55 rads/mc ^{113m}In administered. The major advantages of the ^{113m}In colloid are the low radiation dose, organ selectivity and simplicity of preparation. (auth)

30856 CALCULATION METHOD OF ASSESSING THE FIELD DOSE IN ROTATION GAMMA-THERAPY. Galina, L. S. Med. Radiol., 12: No. 5, 3-1(May 1967). (In Russian).

The proposed method of calculating isodose distributions in rotation irradiation makes it possible to elaborate the picture of the dose field for the chosen program of irradiation (without consideration of the heterogenicity of the irradiated medium). The method is based on the use of equation of the depth dose with the utilization of values of tissue-air ratios and represents a quantitative integration of the dose in the sector of the oscillation angle. Integration is done by several main directions in section of the irradiated medium sufficient for the elaboration of isodoses. A confrontation of the obtained distributions with literature experimental data for ^{60}Co radiation yields a satisfactory coincidence. (auth)

30857 THE USE OF ^{64}Cu TO DIAGNOSE HEPATOLENTICULAR DEGENERATION. Lapchenkov, V. I.; Mashkov, B. A. Med. Radiol., 12: No. 5, 40-3(May 1967). (In Russian).

The paper proposes a method for a radioisotope diagnosis of hepatolenticular degeneration. By way of continuous registration on the band of an automatic recorder for a period of one hour after introduction of ^{64}Cu the isotope is demonstrated to relatively swiftly become incorporated in the liver of healthy individuals, remaining absent in the ill. Subject to inquiry were variations of the ^{64}Cu concentration in 3 patients and 5 healthy individuals during the initial period after administration of the isotope. (auth)

30858 RADIOXENOMETER FOR RADIOISOTOPE DIAGNOSIS OF DISEASES AND INJURIES OF THE SPINAL CORD AND SPINE. Lyass, M.; Frenkel, V. Kh.; El'kund, E. Yu. Med. Radiol., 12: No. 5, 44-6(May 1967). (In Russian).

On the basis of clinical experience it was established that the radioxenometer, elaborated at the All-Union Scientific Research Institute of Medical Instruments and Equipment, makes it possible to carry out radioisotope myelography in clinical conditions and in emergency calls to the patient's bedside. The apparatus is characterized by a high sensitivity and enables the use of only 10 μC of ^{133}Xe. A collimation system of the computer ensures sufficient accuracy of the blocked area, whereas the presence of interchangeable collimators enhances the resolving capacity of the instrument, this being of particular importance in the presence of pathological processes in the cervical region of the spine. (auth)

30859 RING FOCUSING COLLIMATORS FOR SCANNING. Ispenkov, E. A.; Kudin, V. I.; Lyutsko, A. M.; Soshin, L. D. Med. Radiol., 12: No. 5, 59-61(May 1967). (In Russian).

The paper describes ring focusing collimators (of 50 and 75 mm) designated for work with NaI(Tl) 70 × 40 mm/crystal. The open area of the crystal comprises 42 percent. Isocalculating characteristics recorded for radioiodine in air and scanning of the phantom point to the expediency of using such collimators for the scanning of deeply situated foci. (auth)

30860 X RAYS AND RADIUM IN THE TREATMENT OF DISEASES OF THE SKIN. Fifth Edition. Cipollaro, Anthony C.; Crossland, Paul M. Philadelphia, Lea and Febiger, 1967. 830p. $28.50.

The use of x radiation and Ra for the treatment of diseases of the skin is discussed. The basic physics of radiation therapy, as well as clinical applications, are presented for physicians. (C.H.)

30861 BIOLOGICAL BASIS OF RADIATION THERAPY. Schwartz, Emanuel E. (ed.). Philadelphia, J. B. Lippincott Co., 1966. 636p.

Radiobiological research related to radiotherapy is reviewed and interpreted. Separate abstracts were prepared for nine of the 10 chapters of this book. (H.G.D.)

For abstracts of individual chapters see: 30785, 30786, 30862–30865, 30902, 30903, and 30904.

30862 RADIATION RESPONSE AND RECOVERY: RADIOBIOLOGICAL PRINCIPLES AND THEIR RELATION TO CLINICAL PRACTICE. Cohen, Lionel (Johannesburg General Hospital). pp 208-348 of Biological Basis of Radiation Therapy. Schwartz, Emanuel E. (ed.). Philadelphia, J. B. Lippincott Co., 1966.

Two sets of factors affect radiation response and recovery from clinical exposure: the radiosensitivity of tissues and tumors, and technical parameters such as variables that influence dose. Radiosensitivity of constituent cells is modified by: the inherent probability per unit dose of an inactivating event within the normal diploid genome; cytogenetic variation; physical distribution of ions determined by LET and dose-rate; and biological state. Response of tissues and tumors is dependent upon: initial cell population, critical cell assembly, immuno-genetic and antigenic changes, systemic host resistance, and local resistance such as the integrity and nature of vascular and cellular stroma. Technical parameters determining the therapeutic ratio in irradiated tumors include RBE, time factors, volume/surface differentials, heterogeneity factors, and statistical uncertainty factors. (H.G.D.)

30863 MODIFICATION OF RADIATION RESPONSE. Schwartz, Emanuel (Univ. of Virginia, Charlottesville). pp 349-420 of Biological Basis of Radiation Therapy. Schwartz, Emanuel E. (ed.). Philadelphia, J. B. Lippincott Co., 1966.

Radiation response is modified by two sets of variables: biological and chemical. The most outstanding biological variable is species variation. Not only do species vary in sensitivity to whole-body exposure, but vast differences in organ response are found even in closely-related species. Physiological state at time of exposure defines response, particularly in relation to parameters such as age, temperature, hormone balance, mitotic stage, reticuloendothelial function and immunity, and nutrition. Radiosensitivity may be altered chemically by oxygen tension, halogenated pyrimidines and thymidine analogs, and sulfhydryl and related compounds. (H.G.D.)

30864 BIOCHEMICAL CHARACTERISTICS OF TUMORS. Nyhan, William L. (Univ. of Miami, Fla.). pp 421-83 of Biological Basis of Radiation Therapy. Schwartz, Emanuel E. (ed.). Philadelphia, J. B. Lippincott Co., 1966.

Cancer cell biochemistry is directed toward an understanding of the nature of cancer and implications for ultimate therapeutic or prophylactic attack. Therefore, basic research in cellular biochemistry applicable to cancer studies is reviewed. Biological characteristics of tumors are discussed. (H.G.D.)

30865 EXPERIMENTAL APPROACHES TO RADIATION THERAPY. Vermund, Halvor (Univ. of Wisconsin, Madison). pp 518-91 of Biological Basis of Radiation Therapy. Schwartz, Emanuel E. (ed.). Philadelphia, J. B. Lippincott Co., 1966.

A variety of materials and methods have been employed in experimental radiotherapy including: transplantable and spontaneous tumors; heterologous tumor transplants; induced experimental tumors; and in vitro cell cultures. Other aspects of experimental radiotherapy that are reviewed are enhancement of tumor radiosensitivity, environmental factors affecting tumor response, and recovery of normal tissues. (H.G.D.)

30866 PROTECTION AGAINST X-IRRADIATION DEATH BY PARABIOSIS. Sodicoff, Marvin. Cincinnati, Univ. of Cincinnati, 1966. 169p.

Thesis.

The protective value, against x-irradiation death, of bone marrow transplants was compared to that of parabiosis. Parabiosis was the more effective treatment and evidence indicated that recovery was due, in large measure, to transfusion of circulating stem cells from the normal to the irradiated partner. In parabionts, in which one member had been irradiated with 400 R, a leukocytosis was present in the nonirradiated partner. This leukocytosis was marked as early as 2 days after irradiation and surgical union, and persisted for a week, in spite of the loss of leukocytes to the leukopenic partner through the vascular anastomosis which became patent after 2 to 3 days. The cause of the leukocytosis of the normal partner of the x-irradiated, leukopenic rat was investigated. Plasma was obtained from single irradiated (400 R) animals during the fall and subsequent recovery of the peripheral WBC count. This plasma was introduced into recipient animals I.P. and the response of the peripheral WBC count was measured 4 hours later; leukocytosis resulted in these recipient animals, the severity of which correlated with the degree of leukopenia of the plasma donors. Quantitative analysis of the peripheral WBC counts in the plasma recipients indicated that the leukocytosis was due to increases in both neutrophils as well as lymphocytes. The major effect noted in the bone marrow of the plasma recipients was a marked depletion of segmented neutrophils. Injection of plasma from irradiated animals repeated 3 times at 3 hour intervals produced a peripheral leukocytosis, due to increase of both neutrophils and lymphocytes, similar to that observed after a single injection. Expulsion of segmented neutrophils from the bone marrow was also similar to that produced by a single injection; however, the dividing granulocytic precursor compartments, most notably the myeloblasts, were found to be significantly increased at the time of the marrow sampling (9 hours after the first of the 3 injections). At the present time it is not clear whether the apparent hyperplasia resulted directly, through stimulation of the dividing cell population, or indirectly, as a homeostatic response to the depletion of the marrow neutrophil compartment. Parabiotic protection is thought to be the result of the following mechanism: A blood borne factor which has the effect of causing neutrophil release from the bone marrow and hyperplasia of neutrophilic precursors appears as a result of the decrease of the leukocyte population in an irradiated parabiont. This factor is transferred across the parabiotic anastomosis to the normal partner where its activity results in a peripheral leukocytosis, neutrophil expulsion from bone marrow, and a medullary hyperplasia of neutrophilic precursors. The number of leukocytes available for transfusion is thereby increased and so the protective capacity of the blood is increased. This blood may contain increased numbers of cells capable of acting as stem cells for the repopulation of the damaged hematopoietic tissue in the irradiated partner. It is by means of this enhanced availability of circulating leukocytes, which may serve as a temporary support, and the increased numbers of circulating stem cells, which may result in the earlier recovery of the hematopoietic tissues, that parabiosis is effective in protecting against death due to radiation damage. (Dissertation Abstr.)

Radiation Effects on Animals

Refer also to abstracts 30843, 30850, 30852, and 30919.

30867 (N-67-11985) RESEARCH AND DEVELOPMENT PROGRAM FOR RADIATION MEASUREMENTS OF RADIOBIOLOGICAL HAZARDS OF MAN IN SPACE. Summary Technical Report, August 1, 1965–July 31, 1966. (Hughes Research Lab., Malibu, Calif.). July 31, 1966. Contract NAS2-2366. 42p. (NASA-CR-73040). CFSTI $3.00 cy, $0.65 mn.

Data from experimental measurements of the center line depth dose distributions for protons with energies of 20, 45, 137, 220, 260, 630, and 730 MeV are presented and are discussed. The distributions for 20, 45, and 137 MeV protons are characterized by a gradual increase of dose with tissue depth, followed by a sharp peak as the protons approach the end of their range. In other work, spherical proportional counters with various electrode designs were investigated for measuring microscopic dose distributions; and the preparation of spherical silicon Au-i-Al detectors is described. (STAR)

30868 (NYO-3445-13) EFFECT OF IONIZING RADIATION ON THE DISTRIBUTION OF DEOXYRIBONUCLEASES AND PHOSPHATASES IN SUBCELLULAR FRACTIONS OF GUINEA PIG EPIDERMIS. Third Year Comprehensive Report, August 14, 1964–May 31, 1967. Tabachnick, Joseph (Albert Einstein Medical Center, Philadelphia, Pa. Lab. of Experimental Dermatology). Contract AT(30-1)-3445. 13p. Dep. CFSTI.

Progress is reported on studies on the effects of radiation on the distribution of enzymes in subcellular fractions of guinea pig

epidermis. Results are summarized from studies on the effect of β irradiation of the skin on the content of 7 acid and 7 neutral or alkaline epidermal hydrolases. Only acid hydrolase was found to be increased significantly after exposure of skin to 300 rep β irradiation. These findings indicate that the release of destructive acid hydrolases is not a primary radioinduced lesion leading to the death of cells in irradiated epidermis. Histochemical evidence of the presence of lysosomes in guinea pig epidermal cells was obtained. An increase in DNase was observed in irradiated guinea pig skin and appeared to be a general response associated with cutaneous inflammation. (C.H.)

30869 (ORNL-P-3077) A SURVEY OF METHODS FOR THE INDUCTION OF ABERRATIONS IN MEIOTIC STAGES IN DROSOPHILA FEMALES AND FOR OBSERVATION OF THEIR DISJUNCTIONAL PROPERTIES IN THE ENSUING MEIOTIC DIVISIONS. Parker, D. R. (Oak Ridge National Lab., Tenn. California Univ., Riverside. Dept. of Life Sciences). [1967]. Contract W-7405-eng-26. 21p. (CONF-670525-1). Dep. CFSTI.

From IAEA Meeting on the Effects of Ionizing Radiation on Meiotic Systems, Vienna, Austria.

X radiation provides a useful means for disturbing meiotic processes and hence for gaining insight into those processes, the analysis of genetic damage, and the effects of developmental stage on radiosensitivity. The variety of chromosomes available in Drosophila permits the synthesis of special purpose stocks for use in studies on radioinduced chromosome breakage and rejoining, the behavior of newly-induced aberrations in the ensuing meiotic divisions, and factors that affect radiosensitivity. Obtaining identifiable meiotic stages is possible in the case of the female Drosophila, since the meiotic divisions do not occur until after the oocyte is laid, and meiotic prophase extends over a period of approximately a week, making it possible to obtain fairly uniform samples of a single stage by limiting the period of egg collection so that not more than one oocyte is recovered from each ovariole. In the male, meiosis occurs long before the completion of sperm development and the insemination of the female and at best one can distinguish meiotic stages from pre- or post-meiotic ones. Methods are described for the induction of aberrations in meiotic stages in Drosophila females and for observation of their disjunctional properties in the ensuing meiotic divisions. (C.H.)

30870 STUDIES ON MECHANISM OF RESTORATION OF IMPAIRED IMMUNOLOGICAL CAPACITY BY LYMPHOCYTES. II. ANTIBODY PRODUCTION IN THYMECTOMIZED AND IRRADIATED RABBITS, AND EFFECTS OF THORACIC DUCT LYMPHOCYTES ON ANTIBODY PRODUCTION. Nagatani, Yasuo (Kyoto Univ.). Nippon Ketsueki Gakkai Zasshi, 29: 60-8(Feb. 1966).

Rabbits, thymectomized at 7 to 10 days of age and/or x irradiated 1 week later, were tested for immune response to Salmonella typhi, egg albumin, and tubercle bacilli at 6 weeks of age. The effect of injection of homologous thoracic duct lymphocytes at the time of sensitization on the immune response of thymectomized irradiated rabbits was also observed. There was no difference in body weight curves between thymectomized irradiated and sham-operated irradiated rabbits. A reduction in number of circulating lymphocytes was observed in thymectomized rabbits, and this reduction was much greater in the irradiated than in the nonirradiated group. Thymectomized rabbits showed a reduced capacity for production of anti-egg albumin precipitins and development of tuberculin hypersensitivity, but production of anti-Salmonella typhi agglutinins was normal. Reduction of immunological capacity was more evident in irradiated than in nonirradiated thymectomized rabbits. When normal adult thoracic duct lymphocytes were injected intravenously into thymectomized irradiated rabbits at the time of sensitization, capacity to develop tuberculin hypersensitivity was restored to normal and ability to produce precipitins against egg albumin partially restored. Evidently the thymus plays a key role in the development of immunological responsiveness in 7- to 10-day-old rabbits, and thoracic duct lymphocytes participate directly in the immune response. (BBB)

30871 STUDIES ON CELLS PRODUCING HAEMOLYTIC ANTIBODIES AGAINST SHEEP RED BLOOD CELLS IN SHORT-TERM EXPERIMENTS IN VITRO. Strander, H. (Karolinska Institutet, Stockholm). Immunology, 10: 45-55(Jan. 1966).

A method is described for the maintenance of isolated cells from mouse spleens during short periods of time in vitro. X irradiation of the cell suspensions was used to interrupt cell division to ascertain its effect on the number of plaque-forming cells (PFC). After immunization with sheep red cells the largest number of PFC was obtained 4 days later; thus, all in vitro work was performed on this day. X irradiation (1000 R) stopped proliferation of antibody-forming cells, but had no apparent effect on the number of plaques formed. A 10,000-R dose, which probably disturbed other processes besides cell division, also did not influence the number of PFC. 5-Fluorodeoxyuridine (FUdR), which stops DNA synthesis, even in very large doses had no effect on the number of PFC. These results suggest that DNA synthesis does not contribute to the number of PFC during the in vitro incubation prior to the assessment of plaque-forming ability. Thus the action of the various inhibitors on antibody formation tested could not be ascribed to interference with DNA synthesis or cell division. Puromycin, p-fluorophenylalanine, actinomycin D, and hydrocortisone gave dose-dependent effects. γM antibody synthesis was shown to follow the same pattern as mammalian protein synthesis in general. (BBB)

30872 TRANSMISSION OF ANTIMICROBIAL IMMUNITY IN RATS BY BONE-MARROW HOMOGRAFTS. Apateanu, V. (Centrul de Hematologie, Bucharest). Stud. Cercet. Med. Intern. 7: 51-4(1966). (In Rumanian).

The transfer of immunogenic activity via bone marrow to irradiated rats was demonstrated. The recipient rats, of the Wistar strain, were subjected to a 700-R, whole-body dose of 180-kV x rays at a rate of 10 R/min. The bone marrow cells were obtained from donors of the same strain immunized by repeated injections of Salmonella paratyphi B cells. After 3 inoculations the titer of serum agglutinins reached 1:1280. Femoral marrow cells from these donors were then transplanted in the irradiated recipients. The recipient rats developed serum titers of S. paratyphi B agglutinins reaching 1:4 by the 12th day after grafting and of 1:64 by the 30th day. The titer then returned to normal by the 40th day. It is evident that the immunity transmitted by marrow cells is only of a transient nature. The disappearance of antibodies may correspond to the elimination of the homologous marrow graft. (BBB)

30873 RADIO-FREQUENCY ENERGY TRANSPORT INTO THE BODY. Mackenzie, James W.; Schuder, John C.; Stephenson, High E. Jr. (Univ. of Missouri, Columbia). J. Surg. Res., 7: 133-44(Mar. 1967).

Effect of 10^4 to 10^8 cps microwave radiation in dogs and mice were studied, and several r-f energy transport arrangements were considered to indicate ways in which components of the system may be varied in order to improve energy transport. The studies in dogs and mice, exposed on a chronic basis to fields appropriate to energy transport at the 50-w level, revealed no indications of adverse nonthermal effects. Three dogs were exposed to a field equivalent to that required to transport slightly over 50 w, a frequency of 320 kcps being used. Biopsy specimens were obtained from these animals at yearly intervals, at sites on the chest wall. All microscopic examinations of the tissue were substantially negative. In mice exposed for 405 days there were no deaths in the experimental animals, and no gross difference in the growth or activity from control animals was observed. The average life span of the 2 groups was the same. (BBB)

30874 RADIOSENSITIVITY OF BONE MARROW STEM CELLS. Tanaka, Yoshimasa (Tenri Hosp., Japan); Hashi, Masatomo Nippon Acta Radiol., 26: 979-87(Nov. 1966). (In Japanese).

The radiosensitivity of the colony forming cell appearing as a colony in the spleen of the mice which have received lethal x-irradiation and isologous bone marrow transplantation was studied by using d-d N male mice. Experimental methods were essentially the same with those reported originally by Till and McCulloch in 1961, but spleen weight and uptake of ^{59}Fe and ^{125}IUdR by spleen were measured instead of calculation of number of colonies. Experimental results were as follows: Spleen weight and ^{59}Fe uptake by spleen were increased markedly after transplantation of bone marrow cells. The 24-hr uptake of ^{59}Fe by spleens of irradiated (880R) mice was a function of bone marrow cell dose. Linearity of response was achieved over the range 0.2 to 1.6×10^6 cells when the ^{59}Fe citrate was given on day 6 after bone marrow injection. When the transplanted bone marrow (in vivo) were irradiated, ^{59}Fe uptake by spleens exponentially decreased, but the decrease of spleen weight was not so remarkable and not consistent among different experiments. Uptake of ^{125}IUdR by spleens gave almost the same results with ^{59}Fe. The RBE (Relative Biological Effectiveness) of ^{60}Co γ-rays compared with 200 kVp x rays was 0.77 determined from uptake of ^{59}Fe by spleens. Slight protective effect to the bone marrow stem cells was found by the ligation of femoral vessels. Radiosensitization was not so remarkable by the irradiation under 3 atmosphere oxygen compared with air but in the non-irradiated groups, spleen weight and ^{59}Fe uptake were reduced markedly under 3 atmosphere oxygen. (NSA of Japan)

30875 PRODUCTION OF TOLERANCE IN IMMUNIZED MICE AND THE EFFECTS OF IMMUNOSUPPRESSION. Claman, Henry N.; Bronsky, Edwin A. (Univ. of Colorado, Denver). J. Allergy, 38: 208-14(1966).

A study was made of the effect of x irradiation on tolerance to bovine gamma globulin (BGG) in mice, previously immunized with bentonite-BGG, produced by serial injections of soluble BGG. The antigen disappearance rate (ADR) of a tracer dose of ^{125}I-labeled BGG was measured to assess the degree of tolerance or immunity in mice of the CBA/J strain. Larger doses of antigen produced greater degrees of tolerance. A 600-R x-ray dose together with a high dose of soluble BGG produced no greater tolerance than a high dose of BGG alone, but 600 R with a low dose of BGG produced considerably more tolerance than a low dose of BGG alone. In partially tolerant mice 600 R did lessen the antibody responses to a first challenge with bentonite-BGG, and so a second challenge was done. The subsequent ADR values showed that the inhibition of antibody production in normal mice by 600 R had disappeared. Hydrocortisone, used as an immunosuppressive agent, also facilitated the development of tolerance. The concept is discussed that the production of tolerance in immunized mice by repeated antigen injections involves an initial period of increased immunization before tolerance is reached. (BBB)

30876 ON THE INITIAL MECHANISMS OF THE PRIMARY BIOLOGICAL EFFECT OF IONIZING RADIATION. Manoilov, S. E. (Central Scientific-Research Inst. of Roentgenology and Radiology, Leningrad. Leningrad Chemical and Pharmaceutical Inst.). Radiobiol. Radiotherap., 7: 611-26(1966). (In German).

Mechanisms involved in the primary biological effect of ionizing radiation are reviewed. A survey of data from experimental results and published data led to the conclusion that radioinduced death is due to disturbances in tissue respiration. The possible mechanisms involved are discussed. (C.H.)

30877 IMMUNE RESPONSES IN SPLEEN COLONIES. I. CLONAL DISTRIBUTION OF HEMOLYTIC PLAQUE-FORMING CELLS. Celada, F.; Wigzell, H. (Karolinska Institutet, Stockholm). Immunology, 10: 231-43(Mar. 1966).

A study was conducted, in irradiated animals, of repopulation of tissues which takes place through rapid proliferation of a minority of cells which escape severe radiation damage and retain their mitotic capacity. Antibody-forming cells were found in autochthonous spleen colonies, repopulating the spleens of mice which had been exposed to midlethal doses (550 to 600 R) of x radiation and inoculation of sheep red blood cells. This was true only for the secondary response, where a proportion of colonies contained hemolytic plaque-forming cells in variable numbers, ranging from $1/10^3$ to $1/10^6$ nucleated cells within a given spleen. The frequency distribution of antibody-forming cells in colonies suggested a clonal growth at an exponential rate, with a generation time of about 7 hr. It is therefore possible to cultivate and study single clones of competent cells in readily accessible, anatomically distinct regions of the irradiated mouse spleen. The data do not discriminate between the derivation of the antibody-forming clones from the original colony-forming cells, or from a cell seeded-in from the spleen tissue outside the colony. (BBB)

30878 EFFECT OF ESTROGENIC HORMONES ON IMMUNE RESPONSES IN NORMAL AND IRRADIATED MICE. Thompson, John S.; Crawford, Margaret K.; Reilly, Richard W.; Severson, Charles D. (Univ. of Chicago). J. Immunol., 98: 331-5(Feb. 1967).

The effect of estrogen on survival and immunity was studied in sublethally irradiated, lethally irradiated and syngeneic bone marrow transplanted, and nonirradiated mice. When either estradiol or estriol was administered for 2 weeks after x irradiation, excessive early mortality occurred. Evaluation of the allograft and hemagglutinin responses in the animals surviving 4 weeks postirradiation revealed that the St. Luke's myeloma, indigenous to the C3H strain, injected into sublethally irradiated AKR mice, grew progressively and killed most of the estrogen recipients, but regressed in the control-treated irradiated mice; first set allogeneic skin graft survival was prolonged by estradiol in sublethally irradiated mice and by both estrogen in lethally irradiated recipients; and the primary hemagglutinin response to sheep red cells was markedly depressed by both agents in lethally irradiated mice and by estradiol in sublethally irradiated animals. In contrast, neither the survival nor the allograft or hemagglutinin responses were altered by estrogens in nonirradiated normal or pretreated mice. Adoptive immunity was not influenced by hormonal treatment. (BBB)

30879 GAMMA-RAY ATTENUATION COEFFICIENTS OF GRAINS AND FORAGES. Ruwe, Dean M. (Martin Co., Baltimore); Murphy, Glenn; Bockhop, C. W. Trans. ASAE (Amer. Soc. Agr. Eng.), 9: 312-13(1966).

Theoretical and experimental aspects of γ-ray attenuation by stored agricultural products, irradiated for mold and/or insect control, are considered. Expressions were derived for the basic quantity relating γ radiation and its transmission through matter, the attenuation coefficient. Grains and forages are composed of elements having at. no. between 1 and 10. For these light elements, the Compton effect predominates over a wide range of γ-ray energies. It was possible to calculate the electron density of grain from the percentages of the various components. The product of the electron density and the Klein-Nishina cross-section gave the linear attenuation coefficient for a given γ-ray energy. Experimental measurements were made to determine the γ-ray attenuation coefficients for corn, milo, oats, soybeans, and wheat. Results showed that linear and mass attenuation coefficients can be measured accurately and that the measured values are in good agreement with theory. The density of the material and the number of electrons per atomic mass unit (0.536) are the important parameters in determining the attenuation coefficients. The kind of grain or forage and the moisture contents of these materials have negligible effects on the attenuation coefficients. (BBB)

30880 DERMATOLOGIC X-RAY THERAPY. Jadassohn, W. (Hopital Cantonal, Geneva). Dermatologica, 133: 28-32(1966). (In German).

Hyperpigmentation of guinea pig skin is independent of the quality of x irradiation used. The epilation effect is also independent of the quality of the radiation and depends only on the dose that the hair papillae receive. Mitoses were reduced in mammary glands of guinea pigs stimulated with estrogen after irradiation with 400 R of 70-kV x ray. Prolongation of exposure reduces the effects produced. When 1600 R was administered to guinea pigs over an interval of 5 min, the resulting acanthosis and epidermal changes were more pronounced than when the same dose was given over an interval of 1 hr. The significance of prolongation of irradiation is discussed as to its effects in dermatologic practice, and poses a number of questions pertaining to the proper irradiation times to be employed in treatment of dermatologic disorders. It is suggested that empirical methods that have proven valid in treatment should be retained until other procedures that involve shortening or prolongation of an irradiation series are proven to be superior. (BBB)

30881 VIRUS AND PS TUMORS: PROPAGATION IN TISSUE CULTURES OF AN ONCOGENIC AGENT FROM AN EARLY RADIOLEUKEMIA. Mouriquand, J.; Mouriquand, C. (Centre d'Etudes Nucleaires, Grenoble, France). Ann. Inst. Pasteur, 111: 113-24 (Aug. 1966). (In French).

Strain PS cells were originally obtained from a 3½-month-old mouse which developed radioinduced leukemia accompanying spontaneous mammary tumors in the same strain of mice. The mouse had received from the age of 1 month 4 whole-body irradiations of 100 R at weekly intervals. Spleen from this mouse with leukemia was used to prepare cell-free extracts in which a viral agent was sought. These extracts were inoculated into mouse embryo fibroblast cultures, and also injected into newborn Swiss mice. Serial passages in tissue culture demonstrated the presence of a contaminating virus, related to the ectromelia virus. The 217 mice surviving serial inoculations of the culture showed a high tumor incidence, suggesting the multiplication in the cultures of an oncogenic agent issuing from the original extract. The findings are compared with those of experiments on murine leukemogenic viruses in tissue culture. The possible role as a cocarcinogenic agent played by the contaminating virus is considered. (BBB)

30882 EFFECTS OF X IRRADIATION ON ANTIGEN LOCALIZATION IN LYMPHOID FOLLICLES. Jaroslow, B. N. (Argonne National Lab., Ill.); Nossal, G. J. V. Austral. J. Exp. Biol. Med. Sci., 44: 609-28(1966).

The effects of whole-body x irradiation before or after the injection of ^{125}I-labeled Salmonella flagellar antigens on antibody production and antigen distribution in the lymphoid system were investigated. Irradiation (450 R) caused marked depression of both γM and γG responses if given one day before antigen. With a high dose of the strongest antigen, but not with a low dose or with the weaker antigen, it was shown that colchicine could restore antibody-forming capacity, and irradiation after antigen injection actually enhanced the immune response. Irradiation caused changes in antigen localization. The anatomical structure, presumably cytoplasmic fibrils, in the lymphoid follicles responsible for antigen trapping was remarkably radioresistant. Little damage could be observed with doses less than 1250 R, and it took 8000 R to destroy the structure completely. However, the follicular mechanism was not functionally intact. Spleen autoradiographs and whole-organ counts showed a lowered capacity of the web to retain antigen. Lymph node autoradiographs showed abnormal persistence of labelling in a subsinus rim of cortical phagocytes, indicating x-ray-induced interference with antigen migration. Irradiation had no observable effect on the sinus macrophages of the lymph node medulla, suggesting that their function is less

specialized than that of the follicular antigen-retaining cells. (BBB)

30883 FREE RADICALS AND HEALTH: INDICATORS FOR A UNIFYING CONCEPT. Boenig, Herman V. (Spindletop Research Center, Lexington, Ky.). J. Amer. Geriat. Soc., 14: 1211-20(Dec. 1966).

Evidence is reviewed relating to the deleterious effect of free radicals produced by ionizing radiation and other physical and chemical agents. Mode of action of radiation and extent of radical production by various types of radiation are also considered. Free radicals may be induced in tissue by radiation. Data indicate that 10-100 ev of energy are required for radical production, and that radical production in irradiated biochemicals is a highly efficient process. Practically all of the known amino acids have been subjected to ESR measurements after irradiation, and in general, all spectra indicate the presence of one or more free radicals. The somatic mutation theory of aging and the possible significance of irradiation to aging are also discussed. The fact that radiation seems to accelerate the aging process and is also one of the most potent mutagenic agents known is cited as evidence in support of the theory. Similarities between physiological and radiological aging are discussed. The margin of organ tissue reserve appears to be smaller in older individuals and in chronically irradiated animals. Knowledge of aging has received major impetus from radiation studies, especially whole-body irradiation of animals. Relations between radiation, life expectancy, and the normal aging process are now generally recognized. The processes by which radiation-induced mutations occur may be essentially the same as the processes leading to spontaneous mutation. Irradiation of living tissue results in increased ESR signals and in degeneration characteristics which may be similar to effects of mutation, aging, and carcinogenesis. Radiation-induced free radicals of the type $HO\cdot$, $HO_4\cdot$, and $RO\cdot$ are known to exist in nonirradiated tissue, however. Since most oxygen utilization occurs in the mitochondria, these radicals may initiate oxidation, polymerization, and other reactions involving the unsaturated mitochondrial lipids. It is postulated that biological aberrations in DNA and RNA are essentially due to free-radical reactions. They may result in malfunctioning or erratic functioning of biological components, i.e., changes which contribute to cell aging. One form of cell aging may result in nuclei aberrations favoring carcinogenesis. Typical of this form is the accelerated aging induced by irradiation. The concept of molecular aging is extended to a concept of molecular carcinogenesis. Each interaction between a tissue component and a free radical will decrease the amount of effectively functioning tissue. This concept thus refutes the assumption of innocuousness of subthreshold quantities of free radicals, and agrees with the concept that there is no safe limit of irradiation. (BBB)

30884 CHANGES IN THE PERIPHERAL BLOOD OF PATIENTS WITH CANCER OF THE LUNG AND CERVIX UTERI DURING MEGA-VOLTAGE X-RAY THERAPY. Gabelov, A. A.; Gorbacheva, K. V.; Evdokimov, N. M.; Strashinin, A. I.; Sefer'yants, A. F. (Central Research Roentgeno-Radiological Inst., Ministry of Public Health, USSR). Vop. Onkol., 13: No. 5, 49-54(1967). (In Russian).

Alterations in leukocyte and thrombocyte count, leukocytograms, and in blood clot retraction were studied in 19 patients with cervix uteri cancer and 22 patients with cancer of the lung who underwent mega-voltage x-ray therapy. The results indicated that leucopenia developed because of a reduction in the number of lymphocytes and nuclear segment neutrophils and a reduced rate in blood clot retraction. Changes in the thrombocyte count and correlation of elements in thrombocytograms (a shift to the left) both prior to treatment and during x-ray therapy were found mostly to be relative to the state of the tumor process. (auth)

30885 RADIOSENSITIVITY OF MIXED TUMORS OF THE PAROTID SALIVARY GLAND. Gol'bert, Z. V.; Dar'yalova, S. L. (Herzen Research Inst. of Oncology, Moscow). Vop. Onkol., 13: No. 5, 62-70(1967). (In Russian).

Clinical and morphological changes in mixed tumors of the parotid salivary gland developed as a result of the postoperative γ radiation therapy in 60 patients. Revealed changes indicated that these neoplasms could be included in the group of radiosensitive tumors. (auth)

30886 EFFECTS OF THORIUM DIOXIDE UPON BLOOD CLOTTING AND PLATELETS. II. IN VIVO STUDIES IN RABBITS. McGehee, W. G.; Hjort, P. F.; Rapaport, S. I. (Univ. of Southern California, Los Angeles). Throm. Diath. Haemorrh., 16: 354-70(Dec. 1, 1966).

Marked changes in platelets, clotting factors, and white blood cells were found after injecting the standard so-called blocking dose of thorium dioxide suspensions (3 ml/kg body weight) into rabbits. Platelet levels immediately decreased and took more than 24 hr to return to normal. Abnormalities of platelet morphology were also noted. Granulocytes decreased immediately but returned to normal or higher than normal levels in 1 hr. The thrombin time immediately increased, and its return to normal paralleled the clearance of thorium dioxide from the blood. Fibrinogen decreased slightly but not significantly. Factors II, V, VII, VIII, IX, and X dropped progressively over 8 hr to levels between 5 and 40%. Low levels of these factors persisted for several hours after the thorium dioxide had disappeared from the blood. Modest decreases were also noted in factors XI and XIII. The clotting factor abnormalities were more marked with unfiltered (TDS) than with filtered (Thorotrast) suspensions of thorium dioxide, and cardiac tamponade after heart puncture occurred more frequently in the TDS-treated animals. It was concluded that a rabbit prepared for the generalized Shwartzman reaction with thorium dioxide has a severe hemostatic defect when it receives the triggering injection of endotoxin 8 hr later. (BBB)

30887 RADIOAUTOGRAPHIC STUDIES OF THE EMBRYONAL DNA METABOLISM AFTER A SINGLE TOTAL-BODY X IRRADIATION OF THE WISTAR RAT AT THE 11TH DAY OF PREGNANCY WITH 150 R. Wegner, Gert (Univ., Freiburg i. B.). Z. Gesam. Exp. Med., 139: 798-809(1965). (In German).

Embryonal DNA metabolism was studied with radioautography by use of tritiated thymidine after a single x-ray dose of 150 R was given to female rats on the 11th day of pregnancy. Evaluation of the ^3H-labeling index and mitotic index of the following organs was performed: brain (tel-, di-, and mesencephalon), heart, liver, gut, and kidney. An acute disturbance in DNA metabolism was found to occur 1 to 15 hr after irradiation. The ^3H index was extremely low between 2 and 5 hr, in brain it was decreased to 70% of normal and in the remaining organs to about 50%. A decrease of the mitotic index was noted for 24 hr. In addition to this acute effect there was a more prolonged disturbance of DNA metabolism along with degenerative alterations of cells continuing for 5 days after irradiation. In 40% of these embryos, development of hydrocephalus was observed. The radioautographic studies revealed an inhibition of DNA synthesis due to irradiation, with partially irreversible damage of the DNA-synthetizing cells. (BBB)

30888 ANTIBODY FORMATION AFTER HOMOTRANSPLANTATION OF IMMUNOLOGICALLY COMPETENT CELLS. Tumanyan, M. A. (Gamaleya Inst. of Epidemiology and Microbiology, Moscow). pp 419-26 of Molecular and Cellular Basis of Antibody Formation, Proceedings of a Symposium, Prague, June 1 to 15, 1964. New York, Academic Press, 1965.

Antibody formation after transplantation of bone marrow, lymphoid, and thymus cells was studied in animals which had received a lethal dose of irradiation. Passive anaphylaxis was used for detection of antibodies in mice of the strain CC-57-B_2 irradiated with a 750-R dose of γ rays. They were injected intravenously 1 hr after irradiation with the bone marrow from nonirradiated mice. Passive anaphylaxis, tested in guinea pigs, indicated that after transplantation of homologous bone marrow into irradiated animals an immunologic response develops which is due to the presence of antibodies produced both by the transplant against the host cells and by the host against the transplant cells. Similar findings were obtained in irradiated mice injected with homologous lymphoid cells derived from cervical and axillary lymph nodes of donors. Transfer of thymus cells in similar amounts did not prevent death of irradiated mice during the first month, and these mice showed no antibodies; a larger number of cells resulted in the immediate death of the recipients. After injection of lymphoid cells from immunized animals, antibodies in irradiated recipients were detected only in the 3rd week. However, antibody formation was also demonstrated in the recipients receiving killed lymphoid cells. Thus, antibodies were detected in recipients injected with lymphoid cells from immunized donors, both in the inductive and in the productive stage of antibody formation. Irradiation of animals did not completely inhibit antibody formation, but only delayed it, since antibodies could be detected by the end of the second week after injection of lymphoid cells containing antigen. Immunologic activity of bone marrow and spleen cells of irradiated guinea pigs was also studied, with regard to antidiphtheria toxin immunity. Guinea pigs were γ irradiated with an absolutely lethal dose (600 to 650 R). Twenty-four hours later they were injected with hemopoietic tissue from normal or toxoid-immunized homologous donors. These experiments demonstrated that antibody formation in irradiated recipients is caused by donor cells, both sensitized and normal. Transfer of the spleen cells from immune donors led to antitoxin formation of the secondary response type, if immunization was begun during the first month after cell transplantation. This shows that the donor cells retain their immunologic activity in the body of the recipient for a month, but the capacity to produce antibodies may be retained for a longer period. (BBB)

30889 STUDY OF BIOLOGICALLY SIGNIFICANT FORCES FOLLOWING LASER IRRADIATION. Mendelson, Janice A.; Ackerman, Norman B. (Edgewood Arsenal, Md.). Federation Proc. Transl. Suppl. 14, 24: S111-S15(Jan.-Feb. 1965).

Attempts were made to determine which forces in a laser beam, if any, could significantly injure a large animal or man if a laser beam were to strike a surface other than the eye. Studies with a ruby laser revealed that, after short-pulse radiation under sp conditions, pressure waves of low intensity passing into tissue are detectable. These are attenuated so rapidly that they do not appear capable of producing significant biological effects. Very intense heat occurs at the point of focus of the long-pulse laser beam, but these heat effects are sharply localized. Skin and muscle act as semitransparent media, permitting a laser beam to focus deep to the surface without gross alteration of the tissue through which it passes. The physical effects of both the short-pulse and long-pulse lasers are so rapidly attenuated on passage through tissue at the energy levels studied that significant, acute nonocular damage in man is not probable except possibly on exposure of thin-skinned areas. (BBB)

30890 CYTOLOGICAL CHANGES IN BONE MARROW AFTER REPEATED EXPOSURE TO IONIZING RADIATION. Wichrzycka, Elzbieta; Leszko, Bozena (Inst. of Hematology, Warsaw). Bull. Pol. Med. Sci. Hist., 9: 123-6(July 1966).

Mitotically connected abnormalities (MCA) were estimated in 24 bone marrow samples from 16 persons, repeatedly exposed to ionizing radiation during work. The abnormalities seen comprised: chromosomal bridges in anaphase, stranded chromatin, multipolar mitoses, binucleated cells, cells with cytoplasmic bridges, and giant cells. No relation was found between the years of occupational exposure, leukocytosis or lymphocytosis, and the detected abnormalities in the material studied. In 12,000 examined erythroblasts about 9% demonstrated MCA. Most frequent were karyomeres, in a ratio 57.7:1000. Binucleated erythroblasts were detected in a ratio of 8.1:1000. Considering cytoplasmic bridges as an analogous abnormality, the ratio reached 16.9:1000. The incidence of MCA in the granulocytic stem cells (counted together with the erythropoietic series) was 0.3:100 erythroblasts, which was a 10-fold higher ratio than for controls. About one-third of all mitoses demonstrated MCA. For example, 2 multipolar mitoses were detected per 1000 erythroblasts, which is considered a high ratio, since such an abnormality was not encountered in 53,000 erythroblasts from healthy blood donors. The type, number, and distribution of mitotically connected abnormalities were similar to those reported in persons accidentally exposed to radiation (dose of 22.8 to 368 R) 3½ yr prior to examination. (BBB)

30891 THE SERIAL TRANSPLANTATION OF HEMATOPOIETIC TISSUE IN MICE WITH THE SAME H-2 ALLELE. Dresser, Ann M.; Dresser, D. W. (St. Mary's Hospital Medical School, London). Contract AT(04-3)-41. Transplantation, 4: 655-67(Nov. 1966).

Hematopoietic cells from BALB/c($H\text{-}2^d$) mice were serially transplanted in irradiated C57BL/Ks($H\text{-}2^d$) mice at intervals of 6 to 8 weeks. Two groups of recipients were established, one receiving and donating 50×10^6 bone marrow and spleen cells, the other 5×10^6 cells. The recolonization of the various groups of animals was followed by measuring the amount of donor-type (BALB/c) hemoglobin in the circulation of the recipients. In the first transfer full recolonization was observed in the recipients of 50×10^6 or 5×10^6 cells. However, in the second transfer, while the recipients of 50×10^6 cells from the first stage recipients were fully recolonized by donor cells, the animals receiving 5×10^6 cells abruptly ceased to form donor-type hemoglobin after initial recolonization. Full recolonization was again obtained in the recipients of 50×10^6 cells in the third transfer, but donor-type hemoglobin was found only briefly and in very low levels in the recipients of 5×10^6 cells. A slightly different pattern of recolonization was obtained when the recipients of 50×10^6 cells were not bled before they had been used as donors for the next stage recipients. In these experiments, rejection of the grafted tissue occurred one stage later than in the previous experiments. It is argued that the rejection of the grafted tissue cannot be due to the transfer of insufficient numbers of cells (total number). The possibility of whether this graft rejection is due to genetic differences at loci other than the H-2 locus, or to the effect of a prolonged stimulus to divide produced by repetitive transfers of cells, is discussed. (BBB)

30892 EFFECTS OF PRENATAL X IRRADIATION ON MOTOR PERFORMANCE IN THE RAT. Werboff, Jack; Goodman, Irving; Havlena, Joan; Sikov, Melvin R. (Wayne State Univ., Detroit). Contract AT(11-1)-821. Amer. J. Physiol., 201: 703-6(Oct. 1961).

Pregnant Sprague-Dawley rats received 25-, 50-, or 100-R whole-body x irradiation on either the 5, 10, 15, or 20 day of gestation. Controls were sham-irradiated. Over 500 surviving offspring were evaluated for motor maturation of the upright and righting responses, motor strength, and locomotor learning during the neonatal period. The results indicated that radiation exposure of 100 R on day 15 gestation retards motor maturation of the upright and righting responses. Almost all of the radiation groups showed a decrease in motor strength as compared to the control group, with maximum deficits in the groups receiving 50 or 100 R on day 10 or 15 of gestation. On the locomotor learning measure, the results were not consistent, but the group receiving 100 R on day 15 of gestation was maximally affected. These deficits in motor performance were related to observable motor impairment. It was concluded that low levels of radiation received prenatally can have detrimental effects on the development of motor performances in the rat. (BBB)

30893 INCREASING PROBLEM OF PHOTOSENSITIVITY. Pillsbury, Donald M.; Caro, William A. (Univ. of Pennsylvania, Philadelphia). Med. Clin. N. Amer., 50: 1295-1311(Sept. 1966).

The spectrum of uv light responsible for light sensitivity reactions is discussed, as well as the physical characteristic of uv sources responsible for reactions. Light as produced by the sun has a wide spectrum, between 2500 and 18,500 Å; however, this is subject to great variation in the amount of sunlight reaching the skin. Frequently the wavelengths transmitted to the ground are not shorter than 3300 Å under conditions of smoke and clouds, and this radiation has no sunburn-producing power. Sunburn results from uv radiation between 2500 and 3200 Å, with a maximal effect at 2500 and 3000 Å. Ordinary window-glass will prevent sunburn, though it may produce certain photosensitivity reactions. In studying patients for photosensitivity, the use of readily available artificial uv sources is unsatisfactory; a comparison of composition of such sources with sunlight is made. Most available artificial uv sources are far from representative of the spectrum of natural sunlight, being particularly deficient in the longer wavelengths. Various types of skin lesions may develop after exposure to uv light in amounts much below that sufficient to produce ordinary sunburn. Such reactions are due to an increased vulnerability of the skin to uv light produced by cosmetic and bactericidal preparations applied to the skin; a wide variety of drugs administered internally; a background of systemic disease, including particularly porphyria cutanea tarda, erythropoietic protoporphyria, and lupus erythematosus; and polymorphous photosensitivity, for which no explanation is apparent. The recognition of the various photosensitivity reactions and methods of management are discussed. (BBB)

30894 CLINICAL AND ANIMAL EXPERIMENTS: ASPECTS OF THE ACUTE RADIATION SYNDROME. Birke, G. (Karolinska Sjukhuset, Stockholm). Tidskr. Mil. Halsov., 89: 22-5 (1964). (In Swedish).

Experiments were conducted in rabbits in correlation with patients undergoing radiotherapy to determine the effect of radiation on plasma volume and plasma protein distribution and turnover. These parameters were investigated in adult rabbits which received various whole-body doses of x rays and were injected with ^{131}I-albumin. Plasma volume in control animals varied from 30.8 to 44.0 ml/Kg and the intravascular albumin level varied from 1.4 to 1.9 g/Kg. Turnover of albumin in controls was 0.23 to 0.44 g/day. Albumin turnover and plasma volume remained relatively constant in irradiated rabbits up to doses of 800 R (LD_{50}). As doses rose to 1200 R, however, there was a clear drop in intravascular ^{131}I-albumin levels, indicating a loss of circulating albumin. Plasma volume also declined after supralethal doses. (BBB)

30895 PROLIFERATIVE ABILITY OF IRRADIATED BONE MARROW WITH A DIFFERENT INCIDENCE OF SPONTANEOUS CHROMOSOMAL ABERRATIONS. Karpfel, Z.; Koukalova, Blazena (Inst. of Biophysics, Brno). Folia Biol. (Prague), 13: 146-9(1967).

The ability of irradiated bone marrow to repopulate was studied in a set of experiments. The number of spontaneous chromosomal aberrations in bone marrow of individual mice was ascertained in one femur; bone marrow from the other femur was irradiated with 300 R and injected into lethally pre-irradiated recipients at exposure of 600 R. It was found that bone marrow exhibiting a higher number of spontaneous aberrations had a decreased proliferative ability as estimated by spleen weight, marrow cellularity and the number of haematopoietic tissue colonies in spleens of the recipients. (auth)

30896 INDIVIDUAL DIFFERENCES IN THE POST-IRRADIATION SURVIVAL OF RATS AND THEIR RELATION TO THE FLUCTUATIONS IN THE URINARY EXCRETION OF 5-HYDROXYINDOLEACETIC ACID. Taceva, Jaromira; Pospisil, M. (Inst. of Biophysics, Brno). Folia Biol. (Prague), 13: 164-6 (1967).

The post-irradiation excretion of 5-hydroxyindoleacetic acid was determined in rats given a single whole-body exposure of 800 R. It was ascertained that the prognostic significance may be ascribed to the dynamics of the mentioned parameter. The higher radiation sensitivity manifesting itself in mortality of the animals is accompanied by a low or a high degree of intraindividual variability of the postirradiation excretion of 5-hydroxyindoleacetic acid, as compared with a medium degree of fluctuation of this parameter observed in surviving animals. (auth)

30897 X-IRRADIATION AND WING RETENTION IN THE COMMON HOUSE FLY, MUSCA DOMESTICA L. Rockstein, Morris; Bhatnagar, Prem Lata (Univ. of Miami, Florida). Naturwissenschaften, 53: 702-3(1966).

Pupae of the common house fly, Musca domestica, were x irradiated at doses from 10,000 to 30,000 rads. The number of deaths and degree of wing retention were checked for all successfully emerging adults. In control groups, 7% died with 100% intact wings and 73% showed complete wing loss. With increasing doses of x radiation, wing retention was more pronounced, and at 30,000 rad, all the females and nearly all the males had intact wings at death. These high doses act in a restorative fashion, insofar as normal aging processes in the adult are concerned, both by increasing life span and delaying the otherwise characteristic loss of wings early in adult life. (C.O.)

30898 SENSITIVITY OF EARLY DEVELOPMENTAL PROCESSES TO GRADED DOSES OF ULTRAVIOLET IRRADIATION. Rieck, A. F. (Marquette Univ., Milwaukee, Wis.). Bull., Mt. Desert Isl. Biol. Lab., 5: 36(Jan. 1966).

Unfertilized eggs of Echinarachnius parma were uv irradiated ($\lambda > 260$ mμ) and kept in the dark to study the effect on early development. Delay of the cleavage interval indicated this to be the most sensitive process; it was the only detectable effect of uv at doses of 1.42×10^5 erg/cm^2 and lower. Energy levels of 6.16×10^6 erg/cm^2 were required for 80% killing, measured by the capacity of the irradiated eggs to be fertilized and to cleave. Of eggs that divided, none progressed beyond the 4-cell stage. Fertilization membranes were not elevated after 3.13×10^6 erg/cm^2, but 70% of the eggs could be fertilized and would cleave, although none developed beyond the 16-cell stage. These divisions were not the result of uv activation, since none of the irradiated eggs would divide unless sperm was added. At doses between 0.569 and 2.28×10^6 erg/cm^2, 100% fertilization and early cleavage occurred, but the lower dose was considered the LD_{50}. At the LD_{50}, development was normal, but delayed, to the early gastrula stage. This was the critical period, about 50% failing to undergo normal gastrulation. As doses increased, the percentage failing to gastrulate increased so that at 1.14×10^6 erg/cm^2 <1% completed gastrulation, even though 50% were normal late blastulae. Abnormal cleavages also increased. At 2.28×10^6 erg/cm^2 only 50% achieved the early blastula stage, because after the second cleavage the divisions became unequal. These effects, except for the initial killing, were markedly reduced under conditions of maximum photorecovery. The results indicate that development can be substantially affected at gastrulation even though cell division and morphogenesis proceeded normally, but delayed, until this period. The lesion which causes failure in gastrulation is separate from the photo-lesion, which results only in a delay in cell division. LD_{50} doses to unfertilized eggs kept in the dark inhibited ^{14}C-valine incorporation 50%, but uptake at the first cleavage was normal, although delayed. (BBB)

30899 ANTIGEN LOCALIZATION IN LYMPHOPENIC STATES. II. FURTHER STUDIES ON WHOLE-BODY X IRRADIATION. Williams, G. M. (Medical Coll. of Virginia, Richmond). Immunology, 11: 475-88(Nov. 1966).

The gross and microscopic distribution of ^{125}I-labeled polymerized flagellin from Salmonella adelaide was studied in adult rats at various times following 800-R whole-body x irradiation. Injections of radioactive antigen were made in both hind footpads, and the popliteal lymph nodes were excised for autoradiographic study one day later. Irradiation caused a progressive decline in the ability of lymphoid follicles of popliteal nodes to capture and retain antigen. Irradiation had no detectable effect upon antigen uptake by whole lymph nodes or upon ^{125}I in the phagocytic cells of the medullary sinuses of popliteal nodes. Various substances capable of restoring follicular antigen uptake in the irradiated rat were studied by means of injecting the test substance into one hind footpad 1 hr prior to the injection of antigen into both feet. Distribution of antigen in each popliteal node was compared, each animal thus acting as its own control. It was found that 0.01 ml of sp antiflagellar immune serum or 0.25 ml of normal adult rat serum significantly improved follicular antigen uptake when tested 10 days after irradiation. Fetal calf serum, homologous lymphocytes, and the media from pooled concentrated lymphocyte cultures had no demonstrable effects when given by regional injection. Shielding of the popliteal nodes at the time of irradiation improved follicular antigen uptake, whereas shielding of the femoral bone marrow and appendix was ineffective. No agent found capable of improving follicular antigen capture in the irradiated rat significantly altered footpad retention of antigen, whole organ counts of the popliteal nodes, or antigen localization in the phagocytic cells of the lymph node medulla. Evidently, the follicular antigen trapping mechanism is extremely sensitive to changes in levels of opsonins. Substances present in normal adult rat serum seem to act as follicular opsonins and these substances which decline exponentially following irradiation seem to be secreted by small lymphocytes or their progeny. (BBB)

30900 SPONTANEOUS SODIUM CHLORIDE APPETITE OF IRRADIATED ADRENALECTOMIZED RATS. Pospisil, M. (Inst. of Biophysics, Brno). Naturwissenschaften, 53: 553(1966).

Rats were adrenalectomized and one group of them was irradiated 24 hours later. All rats were given a choice between tap water and sodium chloride solution. The results showed a significantly lower intake of salt in irradiated rats as compared with non-irradiated. No differences between the two groups in water intake were observed. A decrease of sodium excretion in urine occurred after irradiation; it is suggested that this might indicate sodium retention which could explain the results. (H.L.W.)

30901 RADIATION RESPONSE OF MAMMALIAN TUMOR CELLS. I. REPAIR OF SUBLETHAL DAMAGE IN VIVO. Belli, James A.; Dicus, Greta J.; Bonte, Frederick J. (Univ. of Texas, Dallas). J. Nat. Cancer Inst., 38: 673-82(May 1967).

To answer certain questions concerning the ability of mammalian tumor cells to repair sublethal radiation damage in vivo, the 2-dose recovery response of the P388 lymphocytic tumor of the DBA/2 mouse was studied as a function of tumor age at the time of the conditioning dose. Aerobic (1-day) and hypoxic (6-day) tumors demonstrated early repair of sublethal damage; the rate of recovery was slower in 6-day tumors. In addition, the maximum degree of recovery in tumors of either age was of the same order of magnitude as the extrapolation numbers observed from single dose-survival curves. Complete recovery, i.e., return of threshold response similar to that observed with nonirradiated cells, occurred within 24 hours after the conditioning dose. (auth)

30902 EFFECTS OF RADIATION ON CELLS. von Borstel, R. C. (Oak Ridge National Lab., Tenn.). pp 60-125 of Biological Basis of Radiation Therapy. Schwartz, Emanuel E. (ed.). Philadelphia, J. B. Lippincott Co., 1966.

Kinetic considerations of the interaction of radiation and matter are summarized. When radiation interacts with a living cell, the resulting injury is either cell death, mutagenesis, or delay in cell division. Repair of cellular injuries induced by radiation is possible; mechanisms for repair are discussed. (H.G.D.)

30903 PATHOLOGIC EFFECTS. Upton, Arthur C. (Oak Ridge National Lab., Tenn.). pp 126-62 of Biological Basis of Radiation Therapy. Schwartz, Emanuel E. (ed.). Philadelphia, J. B. Lippincott Co., 1966.

Radiation effects in mammals that are of interest to the radiologist and radiotherapist are reviewed. The pathologic effects of ionizing radiation represent widely diverse end products of reactions initiated at the cellular level. Early effects are caused primarily by mitotic inhibition and cellular destruction. Cell death may become particularly significant when the cells affected are nondividing cells such as lymphocytes, oocytes, or neuroblasts. Extensive injury to tissues and organs or systems of organs may result in the acute radiation syndrome. Late somatic effects are manifest in induction of neoplasia and general shortening of life spans. Genetic effects represent the most important form of radiation injury for the evaluation of extent of injury remains impossible for a long period of time. (H.G.D.)

30904 RADIATION INJURY IN MAN. Cronkite, Eugene P. (Brookhaven National Lab., Upton, N. Y.). pp 163-207 of Biological Basis of Radiation Therapy. Schwartz, Emanuel E. (ed.). Philadelphia, J. B. Lippincott Co., 1966.

Immediate, intermediate, and latent harmful effects of radiation on man following whole-body and/or therapeutic irradiation are summarized. Effects of physical factors such as RBE and LET on the response of the body to whole-body exposure and quantitative aspects of radiation effects on mammals are considered. Types of syndromes produced by uniform whole-body irradiation are reviewed. Radiation injuries are categorized into survival improbable, survival possible, and survival probable for purposes of diagnosis and clinical management. In regard to the treatment of radiation injury, the cardinal principle is that nothing be done without a clearcut clinical indication. The radiation experience

of man stems from exposure to fallout, massive therapy, accidents, and disasters. (H.G.D.)

30905 PATTERN OF CELL DAMAGE DUE TO IONIZING RADIATION IN THE EPITHELIAL LINING OF THE INTESTINE IN HETEROPNEUSTES FOSSILIS BLOCH. Srivastava, P. N.; Ram, S. (Univ. of Rajasthan, Jaipur, India). Experientia, 23: 358-9(May 15, 1967).

The phenomenon of internal postirradiation changes in Heteropneustes fossilis Bloch, a silurid fish, was examined. Particular attention was given to the atrophy and regeneration of the intestinal epithelium. Calcium-45 was added to an aquarium containing 32 fish (avg wt 10 ± 2g) to give an activity of 3820 counts/min/ml. Another aquarium containing an equal number of fish and an equal volume of water served as a control. Three fish from each aquarium were sacrificed at various time intervals during a 12 day period. Portions of intestine from both control and experimental fish were fixed in Bouin's fluid, sectioned at 6 μ, and stained with hematoxylin and eosin, Heidenhain's iron hematoxylin, and Mallory's phosphotungstic acid hematoxylin. The vulnerability and reparation of the epithelium of the intestinal crypts to the beta particles emitted by the ^{45}Ca in relation to time was determined using the above described histological procedure. In spite of the fact that greater uptake of ^{45}Ca into the intestine occurred from the sixth day onwards, complete recovery prevailed so that the intestine appeared normal. It was suggested that this was probably due to the fact that the intestine had become adapted or conditioned to the ^{45}Ca uptake. (B.H.S.)

30906 THE PRESENT STATE OF RESEARCH IN THE FIELD OF THE RELATIVE BIOLOGICAL EFFECT OF FAST ELECTRONS. Kaercher, K. H. (Univ., Heidelberg). Roentgen Bl., 18: 208-13(May 1965). (In German).

A survey of current research on the measurement of the relative biological effects of fast electrons is presented. The effects that are important include those of single or fractionated dosage, and comparisons with effects of x rays and γ radiation of ^{137}Cs and ^{60}Co. All of these factors must be considered. The object studied, its functional status, environmental conditions, energy of the electrons, dose intensity, and source of the electrons must be taken into account. Physical factors are extremely important. Long-term comparative studies of the effects of low and high energy electrons must be conducted in order to ascertain the actual effects of single and total doses on tumors. Total dose intensity and effects of pulsing of the electron beam require additional study. Differences in effects of low or high energy electrons should be more closely studied, with special emphasis on whether fast electrons of 20 to 42 MeV have effects on normal and tumor tissue that are similar to those of photon irradiation. (BBB)

30907 SEMINIFEROUS TUBULE IN MAMMALS. Lacy, Dennis (London Univ.). Endeavour, 26: 101-8(May 1967).

Evidence from a variety of experimental approaches to temporarily inhibit or totally impair mammalian spermatogenesis is presented. The various agents investigated were heat, hormones, and x radiation. Discussions are presented on fertility control in the human male; the cyclic production of sperm; role of the boundary tissue of the seminiferous tubule in the regulation of the environment; and the role of Sertoli cells and residual bodies during active spermatogenesis. (B.H.S.)

30908 MORPHOLOGIC CHANGES RESULTING FROM PHOTOSENSITIZATION OF THE EYE WITH 8-METHOXYPSORALEN: A COMPARISON WITH CONVENTIONAL ULTRAVIOLET INJURY. Freeman, Robert G. (Baylor Univ., Houston, Tex.). Texas Rep. Biol. Med., 24: 588-96(Winter 1966).

The morphologic changes of inflammation were observed in the cornea, anterior chamber, iris, and lens of guinea pigs sensitized to long wavelength (320 to 400 mμ) uv radiation by prior injection of 8-methoxypsoralen (8-MP). No effect was seen in control animals given either long wavelength uv irradiation or 8-MP alone. Even with intense exposures, short and broad wavelength uv radiation injury was limited to the cornea while the 8-MP effect involved inflammation of cornea, iris, and lens. This was explained on the basis of photosensitization to wavelengths which normally penetrate as far as the iris or lens in the case of long wavelength uv radiation, whereas short and mid uv wavelengths are absorbed by the cornea. Photosensitivity injury of the eye should be considered, particularly when patients have been on prolonged therapy with a drug known to have an absorption spectrum in the uv or visible range. The phenothiazines are one such group in common use. On the basis of the findings reported here, a photosensitivity mechanism could produce injury to the eye, not only in the cornea but in the deeper structures and as far back as the retina. (BBB)

30909 EFFECT OF CIRCULATING BLOOD RADIATION WITH AN EXTRACORPOREAL ^{90}Sr SHUNT ON TRANSPLANTATION IMMUNITY IN DOGS AND MAN. Wolf, James S.; Lee, H. M.; O'Foghludha, Fearghus T.; Hume, David M. (Medical Coll. of Virginia, Richmond). Contract AT(40-1)-2459. Surg. Forum, 17: 245-6(1966).

A method of extracorporeal β irradiation was devised for use in dogs and man in which 40 mCi of ^{90}Sr was bonded to 2 silver plates and encased within Lucite and lead shielding through which a coil of Silastic tubing passed. This portable source could then be attached to a chronic external arteriovenous (AV) shunt to irradiate the blood while shielding the remainder of the body. By maintaining a Teflon-Silastic chronic AV shunt in the neck, dogs with and without prior thymectomy received continuous extracorporeal ^{90}Sr irradiation of their blood for periods up to 2 weeks. By immobilizing the AV shunt and the source in a plaster shoulder cast, the shunts remained patent for the radiation period, and the animals maintained their mobility. This method of irradiation was also used in patients during severe rejection crises following renal transplantation. Following chronic irradiation, dogs showed: prompt lymphocytopenia which lasted 3 to 4 weeks but which was not increased by prior thymectomy; diminution of circulating β_2- and γ-globulins in the postradiation period; histologic evidence of lymphocyte depletion of lymphoid tissue and bone marrow; decreased ability of the remaining peripheral lymphocytes to blastogenic activity with phytohemagglutinin in vitro; decreased formation of precipitating antibody to injected foreign protein; and prolongation of renal homograft survival which was increased when irradiation was concurrent with transplantation but not further increased by prior thymectomy. (BBB)

30910 EFFECT OF ULTRAVIOLET IRRADIATION ON CHLORPROMAZINE. II. ANAEROBIC CONDITION. Huang, Chian L. (Univ. of Mississippi, University); Sands, Freeman L. J. Pharm. Sci., 56: 259-64(Feb. 1967).

The uv-induced photosensitivity reaction in the skin of persons being treated with chlorpromazine was studied. Skin discoloration occurs on the exposed portions of the body of patients receiving long-term medication with large doses (300 to 500 mg 3 times a day) of phenothiazines, especially chlorpromazine. Ocular changes seem to precede the skin pigmentation. It appears that these phenomena are directly associated with photo energy of short wavelength uv radiation. The in vitro effect of uv on an aqueous solution of chlorpromazine, which might furnish clues toward the nature of the photochemical reactions taking place in patients under chlorpromazine medication, was examined. The results indicated that the intact chlorpromazine molecule is deposited in the tissues or organs either in the free or bound form, and that when the tissues are exposed to uv energy, photochemical reactions take place to cleave the chloride function on the chlorpromazine molecules to form HCl and, on the other hand, creating free radicals at the site of irradiation. Immediately, a polymerization reaction of these free radicals proceeds to form a polymer which deposits at the site of irradiation along with melanin to cause the skin discoloration. (BBB)

30911 COMBINED EFFECT OF SPACEFLIGHT FACTORS ON SOME FUNCTIONS OF THE ORGANISM. Frank, G. M.; Livshits, N. N.; Arseneva, M. A.; Apanasenko, Z. I.; Belyaeva, L. A.; Golovkina, A. V.; Klimovitskii, V. Ya.; Kuznetsova, M. A.; Lukyanova, L. D.; Meyzerov, E. S. (Inst. of Biological Physics, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Biol., No. 5, 625-43(1966). (In Russian).

Results are reported from experiments on the combined effect of spaceflight factors (acceleration, vibration, and radiation) on some functions of the organism of rabbits (brain hemodynamics, CNS functions, and cell division of hematopoietic organs). (TSS)

30912 RADIOPATHOLOGICAL KNOWLEDGE AS A BASIS FOR RADIATION PROTECTION IN RADIOLOGY. Barth, Gunther (Wilhelm Conrad-Roentgen-Klinik, Giessen, Ger.). Radiologe, 6: 298-303(Aug. 1966). (In German).

Various phases of radiation pathology are discussed, including radiosensitivity of various tissues, recovery from irradiation, somatic irradiation injuries, the acute radiation syndrome produced by short-term whole-body irradiation with γ rays, effects of fractionation of irradiation administered to small skin fields, correlation of irradiation hardness and erythema dose, sequence of reaction to irradiation as measured by skin temperature, acute irradiation injuries in various organs and tissues, relation of the maximum surface dose to the field size during fractionated depth therapy, doses required for temporary x-ray induced epilation, late irradiation injuries of personnel who work with radiation, including injuries to and relative radiosensitivities of components of the hematopoietic system, tumor development, sclerotic changes, fertility, and longevity, typical late injuries from local irradiation received by patients, genetic radiation injuries, and mutation rates. (BBB)

30913 OSMOTIC RESISTANCE OF LEUCOCYTES IN IRRADIATED PATIENTS WITH SLIGHTLY ADVANCED MALIGNANT TUMORS. Svoboda, V. (Country Hospital, Usti nad Labem, Czech.). Neoplasma, 14: 49-57(1967).

The writer analyzes the results of investigations concerning the osmotic resistance of leucocytes in 106 patients with malignant tumors, of whom in 50 osmotic resistance was determined prior to therapeutic x-irradiation and in 56 after irradiation. The method used is described, significant morphological alterations of leucocytes are illustrated by microphotographs. It appears from the accompanying tables and graph that the osmotic resistance of leucocytes diminishes after irradiation. Values measured before and after irradiation differ statistically in a significant degree (level of significance 99 percent). From among the leucocytary components in mononuclear cells, especially in lymphocytes, decrease of osmotic resistance is greater than in granulocytes. Results of the present investigation can be practically utilized. (auth)

30914 STIMULATION OF SPLENIC ANTIGEN UPTAKE AND OF ANTIBODY RESPONSE IN MICE BY INDIA INK OR OTHER "BLOCKADING" AGENTS. Fisher, S. (Inst. of Clinical Pathology and Medical Research, Lidcome, Australia). Immunology, 11: 127-36(Aug. 1966).

Thorotrast (ThO_2), India ink, or other finely divided agents (trypan blue, saccharated iron oxide, and polystyrene latex) and sheep erythrocyte stroma were injected intravenously into mice. The splenic uptake of stroma labeled with ^{131}I was consistently higher in mice treated with ThO_2 and the other blockading agents than in untreated controls, the difference in some experiments being greater than 10-fold. In addition to promoting the splenic uptake of antigen, ThO_2 and some of the other finely divided agents also enhanced the formation of anti-sheep red cell hemolysin in mice immunized with a single intravenous injection of sheep erythrocyte stroma. Thus, in the experimental system employed, there was no evidence of reticuloendothelial blockade by the particulate or colloidal agents used, however, a marked and consistent stimulating effect on the splenic uptake of the antigen was observed. These findings are in accord with a report that treatment with Thorotrast enhances antibody formation to a bacterial antigen and to sheep erythrocytes in mice. The mechanism of such an adjuvant effect exerted by such particulate or colloidal substances is obscure, but a possible explanation is that the stimulation of antibody production is consequent upon the increased uptake of the antigen by the spleen. (BBB)

30915 INFLUENCE OF X RAYS ON THE PHYSICAL PROPERTIES OF NERVE FIBER. Vanselow, K. (Univ., Kiel). Atomkernenergie, 12: 215-18(May-June 1967). (In German).

Results are reported from studies based on the assumption that the electrostatic pressure at resting condition is compensated by the elastic consistence of the axon membrane. It is supposed that the irradiation of nerve fiber causes a change of the elastic consistence of the membrane. The consequently induced variation of the membrane and the resulting variations of the threshold level were studied. (TSS)

30916 APPLICATION OF A COLLIMATED NUCLEAR RADIATION BEAM FOR LOCAL IRRADIATION OF EXPERIMENTAL ANIMALS. Rizaev, U. M.; Zverev, B. P. (Tashkent State Medical Inst.). Uzb. Biol. Zh., 9: No. 2, 17-20(1965). (In Russian).

The mitotic activity of bone marrow in mice was studied during absolute lethal dose irradiation of the whole-body and during local irradiation with doses of 200 and 400 R mixed γ and neutrons from a reactor beam. The inhibited mitotic activity of bone marrow cells exhibited a direct dependence on the radiation dose at the range from 200 to 1000 R. Mitotic activity was distinctly depressed during a certain period after the exposure. The remote radiation effects on the proliferative capacity of marrow cells was observed shortly after exposure and depended on the radiation dose and the areas of exposure. (R.V.J.)

30917 DNA HISTOGRAMS OF IRRADIATED CELLS: THE CASE OF PROPHASE-TRAPPING. Oldfield, D. G. (Univ. of Chicago). Bull. Math. Biophys., 29: 17-32(Mar. 1967).

Radiation slows the progress of a cell through prophase and hence delays the onset of metaphase, and in an extreme case of this phenomenon cells may be unable to progress through prophase at all. In this condition, called prophase-trapping, it is stipulated that cells which are in prophase during irradiation, or which reach prophase after irradiation, remain in prophase. A time-dependent DNA histogram is calculated for an irradiated population of cells under the limiting assumption that the cells cannot pass through prophase due to the effects of the radiation. The population is assumed to increase exponentially prior to irradiation, but after irradiation to neither gain nor lose cells. Chromosome-number dispersion is taken into account in the calculation. The qualitative behavior of the calculated and experimental histograms are in reasonable agreement. The quantitative agreement between the 2 is relatively good at short postirradiation times but is poor at long postirradiation times (i.e. greater than half the doubling time). This suggests that recovery phenomena cannot be neglected at long postirradiation times. (BBB)

30918 III. MAGYAR RADIOLOGUS KONGRESSZUS, BUDAPEST, 1966 SZEPTEMBER 20-22. AZ ELOADASOK KIVONATA. (3rd Hungarian Congress of Radiology, Budapest, September 20-22, 1966. Summaries of the Lectures). Budapest, Hungarian Society of Radiologists, 1966. 142p. (CONF-660944).

Summaries are presented in English for 195 papers presented at the Third Hungarian Congress of Radiology. Forty-five papers discuss recent advances in nuclear medicine, radiation effects on the physiology of man, radiation injuries induced by therapy, and radiation dosimetry. (C.H.)

Radiation Effects on Plants

Refer also to abstracts 30780, 30798, 30902, and 30917.

30919 (TID-3099) COMBINED SUBJECT AND AUTHOR INDEXES TO RADIOBIOLOGY BIBLIOGRAPHIES: TID-3097, BIOLOGICAL EFFECTS OF IONIZING RADIATION AND TID-3098, THE EFFECTS OF RADIATION AND RADIOISOTOPES ON THE LIFE PROCESSES. Bost, William E.; Ward, Helen L.; Voress, Hugh E. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). June 1967. 695p. Dep. CFSTI.

30920 (UH-235P6-3) STUDIES OF THE EFFECT OF IONIZING RADIATIONS ON THE PROCESSES OF CELLULAR PROLIFERATION, MEGASPOROGENESIS, AND EMBRYO-SAC DEVELOPMENT. Progress Report. (Hawaii Univ., Honolulu). May 22, 1967. Contract AT(04-3)-235. 9p. Dep. CFSTI.

Orchids were used to study the effect of ionizing radiations on the processes of megasporogenesis and embryo sac development. Unlike most flowering plants, megasporogenesis must be induced in orchids, and is accomplished by pollination. The stages in the processes of megasporogenesis and embryo sac development occur over a prolonged period of time (50 to 60 days) and this allows ample time to isolate and treat materials in specific stages. Results are reported from studies on the effects of exposure to 500, 7,500, or 10,000 R x radiation on fruit set of Dendrobium phalaenopsis type orchids examined at weekly intervals from 1 to 9 weeks after pollination. Data are included on the induction of chromosome aberrations and necrosis, cellular proliferation, embryo sac development, and megasporogenesis. (C.H.)

30921 RADIOACTIVE PHOSPHORUS (^{32}P) IN PLANT-GROWTH EXPERIMENTS. Alpatova, E. F. Byull. Kirg. Nauch. Issled. Inst. Zemled., No. 8, 120-7(1964). (In Russian).

The responses of corn to various doses of ^{32}P were investigated; the maximum harmless dose was established. Phosphorus-32-labeled preparations of P_2O_5 were used. When the radioactivity of the preparation was 0.05 μCi/mg P_2O_5 (total dose 5 μCi/plant), no destructive changes were observed. Preparations with activities of 0.067 or 0.138 μCi/mg impaired utilization of soil phosphorus; after distribution in the tissues, leaf formation was unfavorably influenced, and generative organ development was retarded. The response of plants to small doses of radiation was influenced by nutritive conditions, temperature, and other factors that control physiological processes. (B.H.S.)

30922 EFFECT OF KINETIN ON THE RESISTANCE OF TRADESCANTIA LEAVES TO ULTRAVIOLET RAYS. Lomagin, A. G.; Antropova, T. A. (Botanical Inst., Moscow). Dokl. Akad. Nauk SSSR, 172: 964-5(1967). (In Russian).

Tradescantia fluminensis Vell leaf cuttings were subjected to ultraviolet irradiation (3.26×10^6 erg/cm^2), and covered with filter paper wetted with a kinetin solution (20 mg/l). The chlorophyll content in irradiated untreated leaves dropped rapidly (by 61% in 9 days); kinetin treatment reduced this chlorophyll loss to 29% and reduced by 8 times the number of cuttings lost in 9 days. It was suggested that the kinetin made up the loss of natural materials destroyed by ultraviolet irradiation, in addition to a stabilizing effect on the nuclein and proteometabolism. (ATD)

30923 ACQUIRED RADIATION RESISTANCE IN SESAMUM. Rajan, S. S.; Issar, S. C. (Indian Agricultural Research Inst., New Delhi). Indian J. Genet. Plant Breed., 26A: 323-33(1966).

Air-dried seeds from selfed single plants of Sesamum orientale (2n = 26) of the N.P. 6 variety were irradiated with x rays at a dose rate of 2200 R/min with doses varying from 10,000 to 100,000 R. The LD_{50} for this plant was found to be above 100,000 R. The X_1 and subsequent generations were examined. In the X_5 generation, seeds from apparently normal plants with no cytological aberra-

tions, as ascertained from pollen sterility screening, were again subjected to irradiation with 70, 80, and 100 KR doses. The twice-irradiated material showed better germination and better stand than even the control, while the once-irradiated material showed reduced germination at all doses, particularly at the highest dose. Differences among the doses were not significant. Observation on the stand up to maturity showed similar trends. False dichotomy of the main stem was a commonly noted radiation effect. Presumably as a result of radiation injury to apical cells of the shoot tip, 2 side branches developed at a height of about 3 in. from the ground level, each branch being otherwise normal. This aberrant branching was not inherited and represented somatic damage by radiation. The frequency of such plants in the once-irradiated group was nearly 3.6 times that in the twice-irradiated group. Pollen sterility was examined as a test for radiation damage, not only for the somatic damage to the tissue but also damage to the chromosomes, resulting in structural aberrations. The frequency of fertile plants was significantly higher in the twice-irradiated group than in the once-irradiated material, indicating that the twice-irradiated group had significantly more pollen-fertile plants than the once-irradiated group. The once-irradiated material had nearly double the number of breaks per chromosome after 100 KR than plants that were irradiated twice. In the control plants only one fruit was borne in the axil while some mutants had 2 or 3 fruits per axil. Such viable mutants were found only in the twice-irradiated group. It is evident that in the response to a given dose of x rays, plants that had a radiation history were less sensitive than ones without previous exposure to radiation. The plants thus appeared to acquire a certain degree of resistance to the radiation by successive radiation treatments. (BBB)

30924 SEED IRRADIATION AND FERTILITY OF COTTON. Ivanov, V. M.; Pistoli, A. S. Khlopkovodstvo, No. 1, 40-1(1965). (In Russian).

Fertility of cotton was improved by irradiating dry seeds with a 2,000 R dose of ^{60}Co in 1962 and with 1,000 and 2,000 R doses of x rays in 1963. Phenological observations revealed that cotton plants developed earlier and grew to a greater height following irradiation of seeds with 2,000 R γ rays and 500 to 3,000 R x rays. The plants also developed a greater number of seed cases with an increased rate of dehiscence. (H.L.W.)

30925 RADIOSENSITIVITY OF COTTON GROWN FROM IRRADIATED WET SEED. Ibragimov, S. I.; Solov'ev, V. P.; Said-Azizov, D. Khlopkovodstvo, No. 1, 37-40(1965). (In Russian).

Wet and dry cotton seeds were treated with γ radiation. A higher degree of radiosensitivity was observed in the wet seeds than in the dry. A positive effect on growth, development and yield resulted from irradiation of dry seeds; a negative effect resulted from irradiation of wet seeds. (H.L.W.)

30926 EFFECTS OF CHRONIC GAMMA IRRADIATION ON PINUS PINEA AND PINUS HALEPENSIS. Donini, B. (CNEN, Rome). Radiat. Bot., 7: 183-92(June 1967).

A histological analysis was made on shoot apices of Pinus pinea and Pinus halepensis collected from plants chronically irradiated in the gamma field (^{60}Co source) at exposure rates of 18.8, 9.0, 4.30 and 2.64 R/day up to 1513 days, from plants exposed to 36.2, 20.6, 5.02 and 2.10 R/day and allowed to recover after receiving 1000 and 4000 R total exposures, and from plants exposed to 10 R/day and removed after total exposures of 200, 400, 500, 600, 700 and 800 R. The radiation response was evaluated by mitotic inhibition of the apical and subapical meristem cells in the shoot apices, necrosis of vegetative buds, and plant death. Different radiosensitivities were found among cells in the apical meristem and between apical and sub-apical meristems. The possible explanation of the different radiosensitivities is discussed in terms of duration of the cell cycle and DNA content of the nuclei. The two species showed very high radiosensitivities even at low exposures. The species P. halepensis, which showed a higher radiosensitivity than P. pinea, has a DNA content per nucleus 17% greater than the latter. The import role of the exposure rate was clearly established for all the parameters studied. At all exposures, the higher the rate the lower was the total exposure needed for a given effect. (auth)

30927 EFFECTS OF THERMAL STRESS AND SIMULATED FALLOUT ON CONIFER SEEDS. Clark, G. M. (Univ. of Toronto); Cheng, F.; Roy, R. M.; Sweaney, W. P.; Bunting, W. R.; Baker, D. G. Radiat. Bot., 7: 167-75(June 1967). (BNL-10830).

Dry seed of Jack pine and Scotch pine were exposed to thermal stress and/or γ-irradiation. Doses ranging from 450 to 8640 R were administered over a 96 hr period at a dose rate made to vary as a power function of time ($t^{-1.2}$) to simulate that of the gamma component in an early fallout area. The dose to reduce germination to 50% by 30 days was 1260 R for Scotch pine and 4890 R for Jack pine. No seed germinated when exposed to thermal stress (425°C) for periods in excess of 3 sec. A dose of 4690 R to seed of Jack pine in combination with a 3-sec thermal stress resulted in a significant decrease in germination and survival (6 months) compared to other treatment groups. Seeds of Scotch pine exposed to thermal stress and 1020 R had an increased germination but a decreased survival. (UK)

30928 EFFECT OF IRRADIATION ON THE PROPERTIES OF POLLEN IN AUSTRIAN AND SCOTCH PINES. Djurbabic, B.; Vidakovic, M.; Kolbah, D. (PLIVA Pharmaceutical and Chemical Works, Zagreb. Univ. of Zagreb). Experientia, 23: 296-8 (Apr. 15, 1967).

Sugars, amylase, and free and bound amino acids were determined in γ irradiated and non-irradiated pollens of Austrian and Scotch pines. Irradiation did not have any marked effect on the amino acid content of pollens of either species, though an insignificant and irregular variation was noted. The concentration of sugar in Scotch pine pollen is more than double the concentration in Austrian pine pollen. Irradiation markedly influenced the amount of amylase enzyme in the pollen, increasing with dose to a maximum at 1000 R. At this maximum dosage, a minimum of reducing sugars also occurs, and the amount of sugar in the Scotch pine pollen almost equals that in Austrian pine pollen. The results are discussed in relation to the genetic incompatibility of the 2 species. (C.O.)

30929 EFFECT OF IONIZING RADIATION ON OXIDATION PROCESSES IN PLANTS. Budnitskaya, E. V. (Lab. of Radiation Biochemistry, Moscow). pp 367-70 of Progress in Photobiology. Christensen, Chr. B.; Buchmann, B. (eds.). Amsterdam, Elsevier, 1961.

The activity of the enzyme system oxidizing unsaturated fatty acids (lipoxidase) in various irradiated plant leaves (wheat, barley, bean, soya, and peas) increased 30 to 50% in the 24 hr following irradiation. After irradiation the free lipids of bean leaves showed peroxides present in much greater quantity than in nonirradiated leaves. Changes in free lipid composition after plant tissue x irradiation was studied in bean (Lalvia) and barley (Viner) seedlings 10 to 14 days old. After the leaves had been irradiated by 1000 to 10,000 R, marked changes in the lipid content were observed. The free lipid fraction in irradiated seedling leaves contained amounts of peroxides 2 to 6 times higher than in nonirradiated ones. A negligible amount of peroxide was formed on irradiation, i.e., 0.16 to 0.42 mequiv/Kg dry weight. However, peroxides in the bound lipid fraction after irradiation underwent changes similar to those of the peroxides in the free lipid fraction. Separation of the free lipid fraction from bean leaves by paper chromatography before and after irradiation revealed that irradiation of these leaves with 20,000 R produced considerable changes in the unsaturated fatty acid content of this fraction. After 4 hr the effect of the ionizing irradiation on almost all unsaturated fatty acids disappeared from the free lipid fraction extract of irradiated plants. Irradiation of leaves in which the lipoxidase was inactivated by steam did not increase peroxide content whereas irradiation of nonsteamed control leaves sharply increased lipid peroxide content. With the increase of lipoxidase activity, the quantity of lipid peroxide increased after quite small doses of radiation (1000 R). As compared with nonirradiated leaves, the peroxide content of the free lipid fraction of irradiated plants increased 2 to 6 times. The free lipid fraction showed considerable changes in its constitution after irradiation. Thus, the effect of ionizing radiation on plant seedlings can be seen in lipoxidase activation, intensification of oxidation in lipid fraction, and accumulation of lipid peroxides which may play an important role in x-ray damage to the plant. (BBB)

30930 A STUDY OF THE MECHANISM OF AIR-ION-INDUCED GROWTH STIMULATION IN HORDEUM VULGARIS. Krueger, Albert P.; Kotaka, Sadao; Andriese, Paul C. (Univ. of California, Berkeley). Int. J. Biometeorol., 7: 17-25(July 1963).

Both positive and negative ions used to treat H. vulgaris seedlings produced significant increases in stem length, integral elongation, wet weight, and dry weight. The growth stimulation roughly paralleled the ionic density. Experiments were undertaken to determine the mechanism of action of gaseous ions in producing growth stimulation. Tritium ion generators were used to maintain ionized atmospheres over the plants for periods up to 34 days. It was found that seedlings grown in a chemically defined Fe-free nutrient solution developed iron chlorosis. When the growth took place in unipolar ionized atmospheres of either charge, the onset of chlorosis was accelerated and this was accompanied by the appearance of large amounts of cytochrome c. Apparently the air ions cause most of the limited store of Fe present in the seeds to be utilized preferentially in the synthesis of cytochrome c and not enough is available to support the normal biosynthesis of chloro-

phyl!. When the seedlings were grown in a substrate containing Fe and were exposed to ionized air, they did not develop chlorosis but exhibited the typical ion-induced increase in growth rate and an increased production of cytochrome c. Here the supply of Fe was sufficient to provide for both the biosynthetic processes. No evidence was found that a change in ratio of free to bound indole-3-acetic acid accompanies the ion-induced stimulation of growth. (BBB)

30931 CYTOLOGICAL CHANGES UPON APPLYING IONIZING IRRADIATIONS ON ROOT TIPS OF PEAS. Vassileva-Dryanovska, O.; Izvorska, N. (Inst. of Plant Physiology, Sofia). Compt. Rend. Acad. Bulg. Sci., 18: 683-6(1965).

The seeds of Earliest-of-All and Moskovsky garden peas and fodder type field peas were irradiated with fast neutrons and γ rays. The first variety was the most radiosensitive and germinating seeds were more sensitive than dry. The cytological effects in the root tip cells were studied. Doses of 10–100R of fast neutrons or 10–500R γ rays caused an increase in no. and size of nucleoli, an increase in cytoplasmic content of RNA, and an intensified cell division. Over 500R γ rays or 100R fast neutrons resulted in smaller nucleoli. Doses over 1000R resulted in irregular, elongated, or crescent-shaped nucleoli which divided frequently by germination (4 or 5 per cell). Doses of 5000R resulted in 1 small nucleoli per cell and cytoplasm poor in RNA with vacuoles. Cells were elongated with reduced division. Doses of 1000R and 500R induced mitotic abnormalities. (TID)

Radiation Effects on Microorganisms

Refer also to abstracts 30781 and 30902.

30932 (NYO-3319-12) CHARACTERISTICS OF THE RADIORESISTANCE OF MICROCOCCUS RADIODURANS AS AFFECTED BY DOSE-MODIFYING AGENTS AND PHASE STATE. Bruce, A. K.; Ianelli, J. R. (State Univ. of New York, Buffalo. Dept. of Biology). 1966. Contract AT(30-1)-3319. 11p. (CONF-660614-11). Dep. CFSTI.

From 3rd International Congress on Radiation Research, Cortina, Italy.

The bacterium Micrococcus radiodurans is highly resistant to both x and uv radiations. Possible reaction mechanisms involved in this resistance are discussed. Results are reported from a study of the effect of phase state on x radiation dose modification by the –SH binding agent p-hydroxymercuribenzoate (HMB) and the radioprotective agent 2-mercaptoethylamine (MEA). Comparative studies were made on the relatively radiosensitive species Escherichia coli and Sarcina lutea. An effort was made to measure the respective roles of direct and indirect action of radiation. Survival curves were determined with 200 kVp x rays in both liquid and solid state in buffer, MEA, and HMB. The response of M. radiodurans differed from that of the other two species. A model is proposed for the uv and x radiation response of M. radiodurans based on its survival and HMB binding properties. (C.H.)

30933 SURVIVAL AND CAPACITY FOR T3 PHAGE OF X-IRRADIATED LONG FORMS OF ESCHERICHIA COLI B. Janikova, Alice (Inst. of Biophysics, Brno). Folia Biol. (Prague), 13: 143-5(1967).

Long forms of Escherichia coli B were induced by irradiating a logarithmic culture with x rays. Their capacity for T3 phage was influenced by ionizing radiation much less than the capacity of normal E. coli B cells. The burst size of T3 phage on long forms was also much larger than on normal E. coli B cells. Long forms displayed greater resistance to x radiation than normal cells. The course of the relationship between log of survival and the radiation dose indicates that it is a complex process. (auth)

30934 APPLICATION OF THE BIERMAN THEORY TO SURVIVAL CURVES OBTAINED ON CHLORELLA PYRENOIDOSA AFTER ACTION OF X RAYS. Gilet, Roland; Terrier, Jacques (Centre d'Etudes Nucleaires, Grenoble, France). Compt. Rend., Ser. D, 264: 1750-3(Mar. 29, 1967). (In French).

The application of the generalized target theory in which it is considered that two successive and ordered collisions are necessary to arrest the multiplication capacity of Chlorella takes better account of the experimental results than the application of the theory where several independent collisions are supposed necessary. (tr-auth)

Radiosterilization and Radiopreservation

30935 (CONF-670202) [CONFERENCE ON] RADIATION PRESERVATION OF FOOD, OAK RIDGE, TENNESSEE, FEBRUARY 2-3, 1967. (Southern Interstate Nuclear Board, Atlanta, Ga. Oak Ridge Operations Office (AEC), Tenn.). June 1967. 100p. Dep. CFSTI.

Separate abstracts were prepared on 11 papers presented at this conference. (C.H.)

For abstracts of individual papers see: 30936–30946.

30936 (CONF-670202, pp 1-7) OVERVIEW OF THE DEVELOPING TECHNOLOGY OF FOOD IRRADIATION. Nabrit, Samuel M. (Atomic Energy Commission, Washington, D. C.).

The role of the U.S. Atomic Energy Commission in the development of radiation preservation of foods is reviewed. It is pointed out that radiation processing is one of the few really new approaches to overcome food spoilage since the development of thermal canning 150 years ago. The AEC program will have spent $11 million from its inception in 1960 through the current fiscal year. The U.S. Army has supported research on food irradiation over a longer period, while the private research investment to date has been modest. Both the technical and economic feasibility of the radiation processing of selected food products have been demonstrated by the AEC program. Several large food irradiation facilities have been constructed throughout the U.S.A. Efforts to obtain Food and Drug Administration clearance for the sale of irradiated foods are discussed. (C.H.)

30937 (CONF-670202, pp 9-13) ARMY FOOD IRRADIATION PROGRAM. Josephson, Edward S. (Army Natick Labs., Mass.).

The design of the U.S. Army food irradiation facility at Natick, Mass., is described. The facility contains two radiation sources, a ^{60}Co γ source and a linear accelerator. A 4.5 million rad dose is used to sterilize foods. Extensive tests on the wholesomeness of radiation processed foods were carried out using animals. Acceptance testing of a number of food items have been carried out in garrison mess halls. Among the radiation processed foods that were favorably received were bacon, ham, pork, pork sausage, chicken, beef, shrimp, and haddock. The importance of radiation processing of foods to the availability of acceptable and nutritious foods for use by the Armed Forces in all feeding situations is discussed. (C.H.)

30938 (CONF-670202, pp 15-27) FDA REQUIREMENTS. Roe, Robert S. (Food and Drug Administration, Washington, D. C.).

Requirements of the Food and Drug Administration for the approval of distribution of radiation processed foods are reviewed. It is pointed out that ionizing radiation is subject to the Food Additives Amendment and radiation processed foods require consideration essential to a sound appraisal of their safety. Applications for the distribution of radiation processed bacon, potatoes, and wheat were approved after extensive tests of these foods in animals. Food and Drug Administration requirements call for 2-year chronic feeding experiments with rats and dogs to evaluate general toxicity, pathogenicity, carcinogenicity, and effects on reproduction of any food additives. Other tests for radiation processed foods include production of induced radiation and effects on microbiological flora. Preliminary experiments on fruits have shown that extrapolation of data from one product to another is not feasible due to the variations in composition of different fruits as regards carbohydrates, acids, and other constituents. (C.H.)

30939 (CONF-670202, pp 29-37) JOINT COMMITTEE INTEREST IN FOOD PRESERVATION: PAST, PRESENT, AND FUTURE. Conway, John T. (Joint Committee on Atomic Energy (U. S. Congress)).

The history of the AEC and Army programs on the radiation processing of foods is reviewed. In general, since 1960 the AEC has sponsored research programs on the use of low-level radiopasteurization to extend product shelf-life and the Army has directed its efforts toward higher radiation dose level food sterilization. Recently the Army and the AEC have built a meat irradiator pilot plant at Natick, Mass., and the Defense Department has agreed to purchase 300,000 pounds of radiation processed meat per year for three years. (C.H.)

30940 (CONF-670202, pp 39-48) IRRADIATION OF GRAIN AND POTATOES. Powers, John J. (Georgia Univ., Athens).

The radiation processing of potatoes for the control of sprouting during storage and the irradiation of grains to control insect infestation during storage are discussed. Both of these applications of electron or γ radiation have been found to be technically feasible. Irradiation of potatoes to control sprouting can be done for approximately 2.5¢ per cwt which compares favorably with the cost of chemical control of sprouting. The quality and wholesomeness of irradiated potatoes are equal to that of chemically-treated potatoes, and shrinkage losses during storage are less. Irradiation of grains to kill insect pests has been found to be more effective than chemical fumigation, but at present irradiation is more costly. (C.H.)

30941 (CONF-670202, pp 49-51) IRRADIATED BACON. Fact Sheet. Wierbicki, Eugen (Army Natick Labs., Mass.).

Radiation processed bacon can be stored at room temperature (70°F) for over two years with little or no diminution in acceptance. In 1963 the U.S. Food and Drug Administration approved the release of radiation processed bacon for public consumption. The radiation processing and packaging of bacon are discussed. (C.H.)

30942 (CONF-670202, pp 53-60) APPLICATIONS OF IONIZING RADIATION IN THE TREATMENT OF DEHYDRATED VEGETABLES. Schroeder, Charles W. (Lipton (Thomas J.) Inc., Englewood Cliffs, N. J.).

Results are reviewed from a series of studies on the effects of ionizing radiations on dehydrated vegetables and cereals. Results showed that irradiation in the range of 0.3 to 4.0 megarad has a beneficial effect in shortening the cooking time of selected dehydrated vegetables and in reducing the microbiological population without detrimental side effects. Feeding studies have indicated that the products are wholesome. The process appears to be economically feasible. (C.H.)

30943 (CONF-670202, pp 61-5) GOOD SCIENCE AND GOOD FOOD. Goddard, James L. (Food and Drug Administration, Washington, D. C.).

The rationale governing the approval of the U.S. Food and Drug Administration for the distribution of radiation processed foods to the public is discussed. Federal regulations and laws applicable to the use of radiation to preserve food are reviewed. (C.H.)

30944 (CONF-670202, pp 67-9) INDUSTRY INTEREST IN FOOD IRRADIATION. Kaylor, John D. (Bureau of Commercial Fisheries, Gloucester, Mass. Technological Lab.).

Developments in radiation processing of fish and seafood in the U. S. are reviewed. Results are reported from a test on the storage life of fresh and radiation processed haddock fillets under commercial shipping and storage conditions. Seafood buyers of sectional, regional, and national chain stores reported that irradiated fillets had a shelf life of 5 to 14 days longer than non-irradiated control samples. The economic impact of this extended shelf life on the marketing of fish is discussed. (C.H.)

30945 (CONF-670202, pp 71-89) FOOD IRRADIATION CHECK LIST OF COST CONSIDERATIONS. Ketchum, Harry W. (Bureau of Business and Defense Services Administration, Washington, D. C.).

Economic factors governing the radiation processing of foods are discussed. It is pointed out that irradiation costs will vary widely for sterilization, pasteurization, disinfestation, and sprout inhibition and will depend largely on the type of radiation source, dose level, product throughput, product handling problems, geographical location of the irradiation facility, and degree of specialization. There are no figures available for use in calculating the costs of food irradiation in volume, although a number of estimates have been made of the cost of irradiating specific food products by different processes. A checklist of cost factors is presented. Based on available data it was calculated that the cost of irradiating meat using a ^{60}Co γ source will be between 1.1¢ and 5¢ per pound, depending upon the efficiency of source utilization. (C.H.)

30946 (CONF-670202, pp 91-5) COMMERCIAL PRODUCTION OF GAMMA PRESERVED BACON. Brown, William L. (Morrell (John) and Co., Ottumwa, Iowa).

The feasibility of the commercial production of γ-preserved bacon was tested in 1966. Pound lots of cured, smoked, sliced bacon were completely enclosed by vegetable parchment, placed in cans, and sealed under vacuum. The canned bacon was shipped by refrigerated truck to the γ processing facility and exposed to 4.5 to 5.6 megarads with an average exposure time of 2 hr. The radiation processed bacon was stored at room temperature until it was cooked and consumed. (C.H.)

30947 ON THE ARTIFICIAL RADIOACTIVITY ORIGINATED IN FOODS BY IRRADIATION IN THE ENERGY RANGE GREATER THAN 10 MeV. Tuchscheerer, Th. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). Atomkernenergie, 12: 71-80(Jan.-Feb. 1967). (In German).

A simple theoretical method for the determination of induced radioactivity in foods irradiated with high energy linacs (E > 10 MeV) is described. Only the (γ,n) reaction is considered. The calculated activity values using nonrelativistic Sommerfeld bremsstrahlung theory are confirmed by experiments. The high energy radiation used resulted from the $^{7}Li(p,\gamma)^{8}Be$-resonance. Induced activity is compared with natural activity of foods and the quantity of ^{90}Sr fallout. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstract 30618.

30948 (MAB-206-M(5)) [METALWORKING PROCESSES AND EQUIPMENT]. Fifth Progress Report, June 1966-April 1967. (National Academy of Sciences-National Research Council, Washington, D. C. Materials Advisory Board). Apr. 1967. Contract DA-49-083 OSA-3131. 20p. CFSTI.

The state of knowledge of mechanisms of ductile failure, formability limits, and mechanical property changes by plastic strain cycling is reviewed. (M.C.G.)

30949 POWDER METALLURGY. PRACTICE AND APPLICATIONS. Sands, R. L.; Shakespeare, C. R. Newnes International Monographs on Materials Science and Technology. Cleveland, Chemical Rubber Company Press, 1966. 270p.

Powder Metallurgy is, essentially, a textbook designed for the metallurgy student but planned such that it may be of use to designers and engineers of other fields. The book contains chapters on metal powders—their properties and production, shaping of metal powders, sintering, engineering components, tool materials, bearing materials, permeable metals, sintered friction materials, electrical and magnetic materials, refractory metals, and miscellaneous applications of powder metallurgy. Though the book is of an elementary nature, sufficient references are given to allow a more detailed study. (M.L.S.)

Corrosion and Erosion

Refer also to abstracts 30389, 30527, and 31906.

30950 (AECL-2690) RECTIFICATION BY OXIDE FILMS ON ZIRCONIUM ALLOYS. Cox, B.; Speirs, D. L. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Mar. 1967. 26p. Dep. CFSTI. CAN $1.00.

Attempts to observe rectification with evaporated contacts on oxide films on zirconium alloys by ac or dc techniques were unsuccessful, when measurements were made at room temperature. Measurements at higher temperatures were confused by the presence of an oxidation potential and current. Rectification was found when specimens were immersed in an aqueous electrolyte, and at temperatures above 250°C when an evaporated gold contact was used. The former effect is well known in other systems and is a property of the electrolyte/oxide combination. The latter phenomenon appears to be due to the formation of a thin reaction layer between gold and zirconia heated in air, and is apparently unique to the use of gold contacts in an oxidizing environment. The frequency dispersion of resistivity disappeared at about 200°C. Irreversible changes in resistivity and capacitance at high temperature were observed only with gold contacts and were apparently due to interaction of the contact with the oxide. These changes coincided with the appearance of rectification in the system. (auth)

30951 (ANL-7227) CORROSION OF ALUMINUM ALLOYS BY FLOWING HIGH-TEMPERATURE WATER. Draley, J. E.; Ruther, W. E. (Argonne National Lab., Ill.). Jan. 1967. Contract W-31-109-eng-38. 20p. Dep. CFSTI.

A hypothesis is proposed relating the increased corrosion of Al alloys in rapidly flowing water (at high temperature) to precipitating colloidal corrosion products in the stream. A series of experiments showed that colloidal graphite and colloidal hydrated Al_2O_3 could significantly reduce the corrosion rate in 260°C water flowing at 7 m/sec. Corrosion rates approximating those obtained in static tests were achieved in the hydrated Al_2O_3 colloid solution. The total corrosion for one week in flowing 260°C water varied with small applied currents, increasing when the sample was made the cathode and decreasing when made the anode. AsO_3 solution gave promise of being an effective corrosion inhibitor for high-temperature corrosion of Al in flowing water. A model of Al-corrosion mechanism is discussed. (auth)

30952 (BAW-3765-2) CORROSION AND HYDRIDING OF ZIRCALOY. Quarterly Technical Progress Report No. 2, January 1-March 31, 1967. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). May 1967. Contract AT(30-1)-3765. 28p. (EURAEC-1856). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

Operational limitations for Zircaloy fuel cladding were studied. The program is divided into two tasks: corrosion and hydriding tests of Zircaloy under heat-transfer conditions to determine the quantity of H absorbed during service, and mechanical-property tests of hydrided Zircaloy to determine the effect of H on cladding properties. The corrosion and hydriding test loop was operated initially on February 22, 1967. Specimen insertion started March 3, 1967, and was completed March 9, 1967. The calculated surface heat flux on all specimens is 600,000 Btu/hr-ft^2. Precorroding of specimens in 800°F, 500-psig steam to apply an oxide film and to introduce H_2 to simulate the condition of cladding at the end of core life began late in the first quarter. Test specimen data indicated that a 120-day exposure would produce the desired end-of-life conditions. After 90 days' exposure, the nine heat transfer specimens and their associated isothermal specimens were removed for an interim examination. All of the heat transfer specimens had undergone excessive oxidation and were no longer usable. Other methods of accelerating oxidation and hydriding are being investigated, so that the end-of-life specimens can be prepared without the risk of losing the specimens through excessive oxidation. (Additional specimens are being prepared to replace the lost specimens.) Hydriding of annealed and cold-worked tensile and burst test specimens was completed through 350-ppM H_2 content. Room-temperature tensile testing of these specimens was completed. Elevated-temperature tensile testing of annealed and cold-worked specimens was initiated and tests were completed through 650°F. A preliminary series of tests was performed to determine the dwell time necessary before testing to yield consistent tensile strength data. It was found that testing a specimen as soon as it reached test temperature yielded variable and inconsistent results, whereas holding the specimens at test temperature for at least 30 min resulted in consistent and reproducible data. (auth)

30953 (EURAEC-1709) INFLUENCE OF SURFACE TREATMENT ON VARIOUS TYPES OF STAINLESS STEELS CORROSION. Berge, J.-Ph. (European Atomic Energy Community). Feb. 9, 1966. 18p. (EUR-2891.e; CONF-660514-5). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

From 3rd International Conference on Metallic Corrosion, Moscow.

The preparation of a metallic surface frequently has a considerable influence on its subsequent corrosion behavior. The distinction made by P. A. Jacquet between the three surface state characteristics is: Geometric characteristics (roughness); chemical characteristics mainly, in this case, passivation layers that may be characterized by an electrochemical method involving the coulometric reduction of this oxide layer in sulfuric acid; and physical or structural characteristics. The superficial cold-work may be assessed by metallographic techniques on sections and by enlargement of the x-ray diffraction lines. The roughness affects the overvoltage in electrochemical reactions; pitting corrosion in ferric chloride is greatly influenced by surface roughness. The effect of initial passivation is very marked in all corrosive media that are not themselves passivating. Superficial cold-work may also modify the corrosion behavior considerably, stress corrosion in magnesium chloride, intergranular corrosion in nitric acid with hexavalent Cr addition, and oxidation in superheated steam. (auth)

30954 (EURAEC-1749) [BEHAVIOR OF STAINLESS STEELS IN SUPERHEATED STEAM]. Quarterly Report No. 5, July 1-September 30, 1966. Chaudron, G. (Centre National de la Recherche Scientifique, Paris (France)). Contract 059-65-7-TEEF (RD). 18p. (EUR-3306). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

The behavior of various stainless steels in superheated steam and the conditions for occurrence of stress corrosion of stainless steel in boiling $MgCl_2$ were studied. Austenitic steels of a high degree of purity, although characterized by a slightly less corrosion rate than commercial steels, showed an intergranular penetration of the oxide. An addition of 600 ppM of C or 3% Mo led to results fairly close to those for commercial steel. Pt additions lowered the corrosion rate of stainless steel in superheated steam. In studies of the layers formed on austenitic stainless steel subjected to the action of boiling $MgCl_2$ it was possible to take off the film formed at the moment when the potential of the sample increased. It was identified with a layer of spinelle-type oxide. (M.C.G.)

30955 (EURAEC-1804) [BEHAVIOR OF STAINLESS STEELS IN SUPERHEATED STEAM]. Quarterly Report No. 6, October 1-December 31, 1966. Chaudron, G. (Centre National de la Recherche Scientifique, Paris (France)). Contract 059-65-1-TEEF (RD). 18p. (EUR-3345). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The passivating films formed on stainless steel during stress corrosion tests in $MgCl_2$ were examined and found to consist of a spinelle-type oxide. The beginning of the structural evolution of high-purity 18/8 martensitic steels during tempering up to 450°C was followed. When tempering did not exceed 2 hr at this temperature, no formation of austenite was observed. The presence of 0.1% of Pt had no effect on corrosion in steam at 600°C, whereas an addition of 1% of Pt gave rise to an improvement of the order of 20%. In H_2SO_4 the presence of Pt considerably altered the H_2 hypertension. The presence of Pt, while facilitating the fast passivation of the steel in $MgCl_2$, increased the tendency to crack formation under stress. (M.C.G.)

30956 (GEAP–5194) STAINLESS STEEL FAILURE INVESTIGATION PROGRAM. Quarterly Progress Report No. 5, April 1, 1966–June 30, 1966. Duncan, R. N. (comp.) (General Electric Co., Pleasanton, Calif. Nuclear Technology Dept.). July 1966. Contract AT(04-3)-189. 35p. (EURAEC–1766). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Corrosion testing of high purity austenitic alloys with controlled impurity additions in $HNO_3 + Cr^{6+}$ indicated that Si and P are of major importance in determining the intergranular corrosion resistance of austenitic alloys. C additions also affect the intergranular corrosion resistance but is highly dependent on heat treatment prior to testing. Mn, S, N_2 and O_2 were found to have minor effects. A neutron activation technique for chloride analysis in reactor corrosion products (crud) was developed. Results from these analyses indicate that a concentration mechanism exists which can result in over 10 ppM chloride in the crud even though the reactor coolant was maintained below 0.1 ppM chloride. Electrochemical studies in high purity water have been extended to 300°C (572°F). Potentiostatic curves have been obtained on various type 304 stainless steel samples at this temperature. Experiments were performed to determine the effects of oxygen concentration and temperature effects on cracking of stainless steels in dilute $FeCl_2$ solutions. No difference was observed at 650°F between dissolved O_2 concentrations of <0.01 ppM and 6 to 8 ppM. A marked difference in the mode of attack on nonsensitized, cold worked, stressed stainless steel samples in dilute $FeCl_2$ solutions was observed as the test temperature was varied. At 650°F the attack was entirely intergranular. At 600°F the cracking was predominantly integranular with occasional transgranular cracks. At 550°F the cracking was completely transgranular with massive corrosion products visible in the cracks. (auth)

30957 (GEAP–5424) SPECIFIC ZIRCONIUM ALLOY DESIGN PROGRAM. Quarterly Progress Report Nos. 15 and 16, October 1966–March 1967. Klepfer, H. H.; Busboom, H. J.; Blood, R. E.; Rooney, D. M.; Armijo, J. S. (General Electric Co., Pleasanton, Calif. Nuclear Technology Dept.). Apr. 1967. Contract AT-(04-3)-189. 28p. (EURAEC–1851). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

A Zr + 2.0 at. % Cr + 0.16 at. % Fe alloy is being evaluated as nuclear fuel cladding. Alloy-clad fuel rods will be irradiated in the Consumers Big Rock Reactor to a target exposure of 15,000 MWd/t. The fuel irradiation was delayed by a variable corrosion performance of the first full-scale vendor batch of alloy tubing and bar stock. The difference between the variable performance by material from the large vendor ingot and the reproducibly excellent performance in the same tests by material from small laboratory melts was caused by nonuniform distribution of coarse intermetallic compounds in the vendor material. Laboratory studies resulted in a proposed process for ensuring fine uniform intermetallics under vendor conditions. Vendor fuel tubing was received and is being characterized in intensive mechanical and corrosion tests. Tubing structure will be characterized by x-ray and metallographic examinations. Cracking during the cold reduction of initial alpha-annealed extrusions was directly associated with a coarse grain layer on both inside and outside diameter surfaces. Later extrusions were not alpha-annealed, and they cold-reduced without difficulty to produce high-quality reactor grade tubing. Process experiments related the cause of the coarse grain layers to exaggerated grain growth during 704°C (1300°F) alpha-annealing of vendor extrusion. The mechanism for grain growth is being investigated. An irradiation program was defined for evaluation of vendor tubing as fuel cladding. (auth)

30958 (NYO–3477-11) AN INVESTIGATION OF THE MECHANISMS OF EROSION BY IMPINGEMENT. Progress Report. Moore, Mark B. (Rutgers–The State Univ., New Brunswick, N. J. Dept. of Mechanical and Aerospace Engineering). June 1967. Contract AT(30-1)-3477. 9p. Dep. CFSTI.

Three separate modes of erosion of ductile metals, using an air suspension of small glass spheres at room temperature as the erosion medium, were identified and examined. The first phase occurs when each impinging particle approaches in a direction nearly perpendicular to the eroded surface, each particle hits the surface only once, and each particle rebounds clear of the surface. The loss of mass in this phase seemed to be due to intercrystalline fatigue. The second phase occurs when the particles approach the surface at an angle other than perpendicular, impinge once, and remain in contact with the surface, moving along the surface. A third phase of erosion appears when the angle of impingement is near 45°. Distinct steps or ridges appear on the surface. This stepwise erosion seemed to be a metal-flow phenomenon. (M.C.G.)

30959 (NYO–3830-1) SURFACE STRUCTURES AND WORK FUNCTION CHANGES IN OXYGEN ADSORPTION ON TUNGSTEN (100). Estrup, P. J.; Anderson, J. (Bartol Research Foundation, Swarthmore, Pa.). May 29, 1967. Contract AT(30-1)-3830. 11p. (CONF-670320-4). Dep. CFSTI.

From 27th Annual Conference on Physical Electronics, Cambridge, Mass.

Previous studies of O_2 adsorption on a W(100) surface were extended to include, besides LEED observations, measurements of work function changes and O_2 coverage. The evidence indicates that O_2 can interact in two distinct ways. At room temperature the adsorption occurs on top of an essentially undisturbed substrate. At higher temperatures O atoms can penetrate the surface and form reconstructed layers. Under various conditions several ordered structures are produced and the work function changes and surface coverage are correlated with these structures. (auth)

30960 (ORNL-TM–1813) EFFECTS OF LIQUID AND VAPOR CESIUM ON STRUCTURAL MATERIALS. Klueh, R. L.; Jansen, D. H. (Oak Ridge National Lab., Tenn.). June 1967. Contract W-7405-eng-26. 29p. Dep. CFSTI.

The corrosion properties of Cs are of interest for applications in thermionic and turbine generator space-power systems. A literature review of Cs corrosion properties was undertaken as part of a parametric study comparing the characteristics of Cs and K as working fluids in Rankine-cycle systems. In the past, Cs compatibility tests have consisted mainly of static capsule tests run for screening purposes, and in many instances, the effects of the impurities present in the Cs and structural materials were not evaluated. Despite these shortcomings, the tests have shown that the rates of corrosion of identical materials in Cs and K are qualitatively the same. (39 references). (P.C.H.)

30961 ASPECTS OF THE PROBLEM OF MATERIALS IN THE PLANTS WHICH ELIMINATE SALT FROM SEAWATER. Songa, T. (Istituto di Ricerche Breda, Milan); Careri, G. Met. Ital., 59: 177-82(Mar. 1967). (In Italian).

The importance of the problem of materials in constructing the plants to eliminate salt is pointed out, and then the concepts relative to the aggressiveness of waters and the corrosive characteristics of the solutions including chloride, particularly seawater, are briefly discussed. The conditions of work of various parts of the distillation plant are examined, and the possibilities of using various metallic materials for each part of the plant are considered from the critical point of view. Examples are given of the corrosion typical of the plants which eliminate salt. (auth)

30962 THE INFLUENCE OF THE SURFACE TREATMENT ON THE CORROSION OF STAINLESS STEELS AND ZIRCONIUM ALLOYS IN HIGH TEMPERATURE WATER AND IN SUPERHEATED STEAMS. Warzee, M. (Recherches et d'Applications pour l'Industries, Brussels); de Dorlodot, P.; Favresse, L.; Hennaut, J.; Sonnen, C.; Berge, Ph. Corros. Anti-Corros., 15: 49-59(Feb.-Mar. 1967). (In French).

Several test bars of stainless steel and of Zr alloy were prepared and their behavior under corrosion in superheated steam and pressurized water was compared. The test results show that the influence of the surface treatment on the corrosion depends not only on the alloy but on the conditions of the oxidizing medium for the same alloy. (auth)

30963 REFRACTORY METALS IN LIQUID METALS HANDLING. Barto, R. L.; Hurd, D. T. Res./Develop., 17: No. 11, 26-9(Nov. 1966).

Properties of refractory metals that are important in liquid metal applications are reviewed. Data and discussion are included on refractory metals thermal conductivity, thermal expansion, density, specific heat, melting points, and compatibility with other metals. (J.R.D.)

30964 CORROSION DUE TO GASES CONTAINING FLUORINE. THE SPECIAL CASE OF DRY OXIDATION. Vincent, L. M. (CEN, Saclay, France). Chim. Ind. (Paris), 95: 611-21(Apr. 1966). (In French).

The techniques developed for the study of corrosion due to gases containing Fl as well as some results of these studies are described. The problems were considered as a gas-solid reaction with the reaction of metals with UF_6 being a special case of this. A parallel is drawn between the different stages of dry oxidation and fluorination. The special properties of the latter are stressed. (auth)

30965 STUDIES ON THE CORROSION OF BORON STAINLESS STEEL IN HIGH TEMPERATURE WATER. Ito, Goro (National Research Inst. of Metals, Tokyo); Sawayanagi, Fumio. Kinzoku Zairyo Gijutsu Kenkyusho Kenkyu Hokoku, 9: 56-63 (Feb. 1966). (In Japanese).

Austenitic stainless steels with small B additions are used for reactor controls. The corrosion behaviors of such austenitic stainless steels containing 1.5 to 1.8% of B were studied in comparison with 18-1 stainless steel containing no B. When 1.8% of B was added to austenitic 18-8 stainless steels the corrosion was increased in 320°C pure water; poorly adhering corrosion products were produced and released out into the water. When 2 to 3% Ti was added in addition to 1.6% of B, with Ni-Cr of 15-17 to stabilize the austenite, the anti-corrosion properties were recovered. The corrosion note was much higher than that for ordinary 18-8 stainless steels. The increase of the corrosion by addition of B was due to the formation of boride and the subsequent decrease in the Cr. The co-existence of Ti inhibited the decrease of Cr, but did not prevent the formation of the ferrite. Since the boride itself had poor anti-corrosivity, the anti-corrosivity as a whole could only slightly be improved. The boride in the composition was far less corroded than others, but its surface was made rough after over 100 hours. (NSA of Japan)

30966 ABSORPTION OF GASEOUS HYDROGEN BY ZIRCALOY-2. Marshall, R. P. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. J. Less-Common Metals, 13: 45-52(July 1967). (DP-MS-66-27).

The absorption of H_2 by Zircaloy-2 and low-Ni Zircaloy-2 was investigated to compare the conditions for formation of localized massive hydride layers with the conditions for homogeneous absorption of H_2. The variables studied were temperature (300 to 400°C), H_2 pressure, Zircaloy surface condition, and texture. No instantaneous reaction of Zr and H_2 to form hydride was observed. Hydride layers formed only when the Zircaloy surface had become saturated with H_2 in solid solution. Layer formation was not specifically associated with any experimental condition. The absorption rate was very rapid and was sensitive to H_2 pressure; layers formed in less than one minute at H_2 pressures of 25 mm. The presence of an oxide film on the metal localized the absorption because H_2 diffused through some areas of the film much faster than other areas. These results showed that small amounts of water in the UO_2 of nuclear fuel elements can cause failures in Zircaloy cladding by the rapid and localized absorption of H_2 from the inside of the fuel elements. (auth)

30967 EFFECT OF SODIUM EXPOSURE ON THE MECHANICAL PROPERTIES OF POTENTIAL FUEL JACKET ALLOYS AT 550 TO 700°C. Yaggee, F. L.; Gilbert, E. R. (Argonne National Lab., Ill.). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-85/21, 24p. (CONF-661110-32). DTIE.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna.

The effect of Na exposure on the mechanical properties of the following alloys was studied: Type 304 Stainless Steel, unalloyed V, V-20 wt % Ti, V-15 wt % Ti-7.5 wt % Cr, and Nb-1 wt % Zr. Concentrations of 20 ppM of oxygen were found to increase the creep rate of samples exposed to Na at 650°C and 15 kg-mm^2 for 7 days by 3 fold. Similarly, the tensile stress of the samples decreased about 10% while the yield stress was essentially unchanged. Ductility and bend tests were carried out also. (B.L.M.)

30968 SPACE-POWER-SYSTEM MATERIAL COMPATIBILITY TESTS OF SELECTED REFRACTORY METAL ALLOYS WITH BOILING POTASSIUM. Rosenblum, L.; Scheuermann, C. M.; Moss, T. A. (Lewis Research Center, Cleveland). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-85/37, 16p. (CONF-661110-28). DTIE.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna.

The compatibility of potential Nb and Ta tubing alloys with boiling K was investigated in the temperature range representative of the upper operational temperatures of a turboelectric space power system. Two types of compatibility tests were employed: reflux capsules for material screening and forced-convection two-phase loop test in which the power system flow rate and temperature gradient service conditions were simulated. Eight alloys were studied in the reflux capsule studies: Nb-4 wt % V; 10 wt % Nb-10 wt % Ta-W; Nb-1 wt % Zr; Nb-10 wt % W-1 wt % Zr-0.1 wt % C; Nb-28 wt % Ta-10 wt % W-1 wt % Zr; Ta-10 wt % W; Ta-8 wt % W-2 wt % Hf; and Ta-9.6 wt % W-2.5 wt % Hf-0.01 wt % C. Many of the alloys were tested in both the as-worked and recrystallized conditions. The initial O_2 content of the alloys was less than 150 ppM and that of the K was less than 20 ppM. The two-phase convection loop was constructed of Nb-1 wt % Zr. Test conditions and results for both the reflux capsules and the convection loop studies are presented in detail. (B.L.M.)

30969 PROBLEMS OF A SODIUM-LOOP DESIGNED TO OPERATE AT TEMPERATURES UP TO 800°C. Matyas, E.; Rajakovics, G.; Schwarz, N. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Vienna. Gebr. Boehler and Co. AG, Vienna). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-85/13, 22p. (CONF-661110-27). DTIE.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna.

A universal Na loop at Seibersdorf, Austria, designed for operation at 800 to 850°C is described. Certain problems concerned with design of the heating section, the corrosion test section, the changing system for the samples, and the heat exchanger for high temperature are discussed. Solutions to certain safety problems associated with the loop are also discussed. (B.L.M.)

30970 DEVELOPMENT OF A LOW-ALLOY FERRITIC STEEL FOR HIGH-TEMPERATURE SODIUM SERVICE WITH SPECIAL REGARD TO CARBON TRANSPORT. Baerlecken, Ewald; Lorenz, Klaus; Kranz, Eckhard; Schlegel, Dieter (Thyssen Roehrenwerke AG, Duesseldorf, Ger.). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-85/44, 16p. (CONF-661110-13). DTIE.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna.

A suitable ferritic material with an adequately low C activity was developed for Na circuits to prevent C transport. Development proceeded from the heat-resistant 2¼ wt % Cr and 1 wt % Mo steel with an addition of the carbide-forming element Nb. The material possesses a sufficiently low C activity to prevent the C diffusion when in contact with austenitic steels, and test results revealed satisfactory mechanical properties and sound warm- and cold-working characteristics, as well as good weldability. Since the Nb acts unfavorably on impact properties, limitation of the Nb-content and additions of suitable alloying elements, such as Mn or Ni, may be necessary to ensure a sufficient degree of resistance to brittle fracture. (B.L.M.)

30971 650°C SODIUM FREE-SURFACE, STRESS, AND WEAR EFFECTS ON REACTOR COMPONENT METALS. Smith, F. A.; Sowa, E. S.; Kimont, E. L.; Sutton, C. R. (Argonne National Lab., Ill.). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-85/22, 32p. (CONF-661110-30). DTIE.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna.

Reactor-component materials, mainly 304 SS shafts, piping, and bellows, as well as bearings made of various materials, were exposed to the 1200 to 1500°F Na environment of interest for future fast reactors. The data are presented and test apparatus described. These preliminary tests showed that at these Na temperatures certain properties of structural materials behave in a significantly more complex manner than they do in the 900°F Na environment of present fast-breeder reactors. (auth)

30972 CORROSION OF STEELS IN THE VICINITY OF A SODIUM-WATER REACTION. Davies, R. A.; Bray, J. A.; Lyons, J. M. (United Kingdom Atomic Energy Authority, Caithness, Scotland). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-85/15, 14p. (CONF-661110-18). DTIE.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna.

Rapid corrosion of steels in the vicinity of Na-water reaction could lead to a major reaction on a Na-H_2O heat exchanger. An investigation of the magnitude of the corrosion problem was carried out under conditions simulating both a small water leak and a full-scale pipe burst, and further tube failures were obtained. These experiments were carried out on a Na rig that could accommodate simple full-scale models of sections of a heat exchanger, and up to 35 lb of H_2O was injected into 700 lb of Na in 4.5 sec. The corrosion phenomenon was also investigated on a small scale under more controlled conditions by pumping H_2O at normal pressures into a pot of Na. With a flow rate of 1 ml/min corrosion rates in excess of 0.0005 in/min were obtained. The effects of various parameters on corrosion rates were studied, and a comparison was made of the corrosion rates obtained with a variety of steels. The corrosion appeared to be a direct result of conditions during the reaction, and the appearance of the specimen and pattern damage suggests that the main effect is concentrated

where the $Na-H_2O$ reaction front impinges on the metal surface. The corrosion rates were very much lower with stainless steel and Ni alloys than with ferritic materials, suggesting that the phenomenon is associated with the formation of $(Na_2O)_2FeO$. Fe powder was also observed in the vicinity of the reaction, which would suggest that this is reduced at a later stage, either as a result of the H_2 produced during the reaction or by thermal cycling. (auth)

30973 CORROSION OF VANADIUM-BASE ALLOYS IN SODIUM AT 550 TO 750°C. Greenberg, S.; Ruther, W. E.; Levin, H. A. (Argonne National Lab., Ill.). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-85/20, 18p. (CONF-661110-23). DTIE.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna.

Vanadium alloys are being investigated as fuel cladding for Na-cooled fast reactors. Vanadium–20 wt % Ti was chosen as the tentative reference alloy and basis for comparison. It was studied in detail under both static and dynamic conditions. The corrosion behavior was particularly sensitive to the O_2 concentration in Na. In static studies at low concentrations (2 to 6 ppM) of O_2 the alloy gained weight in a protective manner, while above about 15 ppM, weight loss proportional to exposure time was observed. Under low O_2 conditions for times up to 475 hr and over the temperature range from 550 to 750°C, most of the experimental results can be expressed in terms of the parabolic rate law, $(\Delta w/A)^2 = K_p t$. The observed weight gains are due to dissolution of O_2 in the metal rather than to the formation of a surface oxide. The variation of the parabolic rate constant with temperature follows an Arrhenius-type relationship. Microhardness transverses indicated that the dissolution of O_2 was confined to rather shallow depth. In a dynamic system (velocity of 6.1 m/sec) at 650°C and O_2 concentrations of 10 to 12 ppM, protective kinetics were also observed. After 139 day exposure, the weight gain may be described by the empirical equation $\Delta w = 0.26t^{0.34}$ (Δw in mg/cm² and t in days). The quantitative difference in the rate laws observed in the two types of experiments cannot yet be explained. Alloy development work is continuing and alloys with corrosion resistance superior to V–20 wt % Ti were developed. (auth)

30974 EFFECTS OF SODIUM ON THE METALLURGICAL AND MECHANICAL PROPERTIES OF CANDIDATE LMFBR ALLOYS. Horton, K. E. (Atomic Energy Commission, Washington, D. C.); Andrews, R. C.; Werner, R. C.; Atkins, D. F. Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-85/33, 20p. (CONF-661110-24). DTIE.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna.

The alloy bases considered as candidates for structural and fuel cladding alloys for the Liquid-Metal Fast-Breeder Reactor Program are being studied. The properties of austenitic and ferritic steels are considered. The Na-effect studies were performed in isothermal loops constructed of type 316 stainless steel. Creep, creep rupture, and bend-fatigue specimens were fabricated from 0.065-in.-thick sheet stock. The alloys were tested in Na having high O_2 content, low O_2 content, and saturation carbon content. The results of these various tests on the alloys are discussed in detail. (B.L.M.)

Preparation and Fabrication

Refer also to abstracts 30401, 30435, 31003, 31036, and 31944.

30975 (AECL-2672) ROLLED JOINT INVESTIGATION SGHWR: PHASE I. Beston, P. G. (Canadian General Electric Co. Ltd., Peterborough (Ontario). Civilian Atomic Power Dept.). Nov. 1962. Reprinted Mar. 1967. 59p. (R-62CAP60). Dep. CFSTI. CAN $1.50.

Investigations were carried out into the feasibility of developing a rolled joint for the S.G.H.W. Reactor between the annealed Zircaloy coolant tube and either a mild steel or 1% Cr–0.5% Mo alloy steel fitting. Joints of adequate mechanical strength were developed using the Cr–Mo alloy steel fittings, but did not prove leak tight during the 500-cycle thermal and pressure test in a rig simulating reactor conditions. (auth)

30976 (DUN-1941) BONDING OF ALUMINUM BY THE CAPACITOR DISCHARGE MAGNETIC FORMING PROCESS. Powers, H. G. (Douglas United Nuclear, Inc., Richland, Wash.). Apr. 1967. Contract AT(45-1)-1857. 13p. Dep. CFSTI.

A procedure is described for bonding caps to Al tubes by a capacitor-discharge magnetic forming-weld. The bonds were He leak tight and of sufficient strength to cause failure of cylinder walls during peel testing. Can wall thickness was reduced less than 10% in the weld zone. Advantages and disadvantages of the method are listed. (P.G.C.)

30977 (EURAEC-1813) STAINLESS STEEL CLADDING OF HEAVY GAGE STEELS. Quarterly Report No. 10, October 1–December 31, 1966. (Soudometal, S. A., Brussels (Belgium). Ghent Rijksuniversiteit (Belgium). Neratoom, N. V., The Hague (Netherlands)). Contract 008-63-12TEEB (RD). 7p. (EUR-3349). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

A new research program to replace the original one has been planned. The initial phase will continue to define the quantitative effect of each welding parameter or condition on the composition of a single-layer metal deposit. The second phase will implement a selection of the optimum solutions for single-layer tape cladding. All the cladding would be effected on slightly alloyed grades of base steels for reactor vessel construction. (J.C.W.)

30978 (IN-1103) THORIUM–URANIUM SYSTEMS, A LITERATURE SURVEY. Fast, E.; Peereboom, R. A. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Aug. 31, 1962. Contract AT(10-1)-205. 10p. Dep. CFSTI.

A brief literature survey was made on Th–natural U systems. The objectives were to determine: feasibility of preparing samples containing Th–U alloys or mixtures; problems associated with sample preparation; what irradiation studies have been made; and what theoretical studies have been made. It was found that most of the studies were made using partly or fully enriched ^{235}U in Th. (38 references). (P.C.H.)

30979 (LA-3703) THREADING AND ASSEMBLY OF SOFT DELTA-STABILIZED PLUTONIUM PARTS. Gilmore, R. R.; Robbins, B. N.; Anderson, J. W. (Los Alamos Scientific Lab., N. Mex.). Jan. 1967. Contract W-7405-eng-36. 5p. Dep. CFSTI.

Delta-stabilized Pu, which is a soft gummy material similar to annealed Cu, is difficult, if not impossible, to thread using conventional taps and dies or thread-cutting techniques. A successful plunge threading technique and a surface preparation method which permits assembly of threaded delta-stabilized parts without galling are described. (auth)

30980 (LA-DC-8676) METALLOGRAPHY OF PYROLYTIC CARBON- AND/OR TUNGSTEN-COATED URANIUM OXIDE AND URANIUM CARBIDE FUEL SPHERES. Bender, J. H. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 8p. (CONF-670533-2). Dep. CFSTI.

From 21st AEC Metallographic Group Meeting, Upton, N. Y.

Procedures for the metallographic preparation of pyrolytic C- and/or W-coated UO_2 and UC fuel spheres are described. These include mounting, grinding, polishing, and etching techniques for optical and electron microscopy. (auth)

30981 (ORNL-P-3133) HIGH-PURITY SHAPE CASTING WITH AN ELECTRON-BEAM FURNACE. Dean, C. W.; McDonald, R. E.; Leitten, C. F. Jr. (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 15p. (CONF-660456-1). Dep. CFSTI.

From 9th Annual Symposium on Electron, Ion, and Laser Beam Technology, New York.

A description is presented of an electron-beam melting furnace to produce laboratory quantities of high-purity metals using a technique that permits molten charges of high-purity metal to be drop cast into cylindrical or rectangular chill molds. Subsequent fabrication is easier and less expensive because of the improved cast structure and more desirable ingot shapes. In addition, a higher material yield is realized. The drop-casting technique and melting equipment may be used to cast fabricable shapes of Ti, Zr, Nb, V, Ta, W, Mo, and their alloys. (auth)

30982 (RSIC-602) DEFORMATION PROCESSING OF STAINLESS STEEL. Strohecker, D. E.; Gerds, A. F.; Henning, H. J.; Boulger, F. W. (Battelle Memorial Inst., Columbus, Ohio). Oct. 21, 1966. Contract DA-01-021-AMC-11651(Z). 355p. (NASA-TM-X-53569).

The state-of-the-art of both primary and secondary fabrication methods for stainless steel are reviewed. Methods currently employed for primary fabrication of these alloys include: rolling, extrusion, forging, and drawing of tube, rod, and wire. Secondary metalworking operations are those processes that produce finished or semifinished parts of sheet, bar, or tubing using additional metalforming operations. The following secondary forming processes are discussed: brake bending, deep drawing, spinning, shear forming, drop hammer, trapped rubber, stretch forming, roll forming, dimpling, joggling, and sizing. Equipment and tooling used for the various operations are discussed and illustrated wherever possible. (128 references). (auth)

30983 (UCRL-13298) HIGH PRESSURE CONSOLIDATION OF VACUUM ENCAPSULATED TUNGSTEN COMPACTS. Final Re-

port. Clougherty, Edward V.; Elling, James (ManLabs, Inc., Cambridge, Mass.). May 1967. Contract W-7405-eng-48. 14p. Dep. CFSTI.

For Univ. of California, Lawrence Radiation Lab., Livermore.

A total of nineteen encapsulated W powder compacts were forwarded to ManLabs, Inc. for high pressure consolidation. The processing conditions of pressure, time, and temperature were specified. The actual conditions employed were generally as specified, but some experimental difficulties were encountered in the measurement and attainment of temperature in several consolidation processings. The pressure and time specifications were generally well satisfied. Such experimental difficulties are not uncommon in the present stage of development of high pressure technology. The experimental details of the pressure and temperature calibration procedures and a description of the apparatuses employed are provided. It was not possible to procure submicron powders of HfB_2 and HfO_2. These powders were to be blended with a particular lot of W powder. Such blends were intended for a processing of compacts formulated to provide dispersion strengthening of the same batch of W previously high pressure processed. This type of strengthening can not be effected unless the dispersoid is present in submicron sizes. Alternate methods of formulating mixtures of W and dispersoids suitable for dispersion strengthening can be employed but such procedures could not make use of a particular batch of W, hence the objectives of the planned study could not be accomplished. It was agreed to delete the procurement, blending, and processings associated with this aspect of the study. (auth)

30984 EUROPIUM ALLOYS. Savitskii, E. M.; Terekhova, V. F.; Torchinova, R. S. (Inst. of Metallurgy, Moscow). Metalloved. Term. Obrabotka Metal., No. 2, 25-31; 33(Feb. 1967). (In Russian).

A series of Ni–Eu alloys containing 0.77 to 37.47% Eu were melted from electrolytic Ni and 99.77%-pure metallic Eu. The alloys were melted in a He atmosphere at a pressure of 0.5 atm, forged and vacuum annealed at 1100°C for 50 hr, or annealed at 1100°C and quenched. All alloys were found to have a two-phase structure. Small individual inclusions of the second phase precipitated within grains of the alloys with Eu content of up to 1.2 wt % and along the grain boundaries in the alloys containing 1.44 wt % Eu. The chemical composition of an alloy with 37.44 wt % Eu (melting temperature 1440 ± 10°C) was close to that of a pure Eu-Ni_5 compound, which had a microhardness of 620 kg/mm². The maximum solubility of Eu in Ni in the solid state was 0.78 wt % (0.3 at. %) at 1100°C and 0 at 20°C. Alloys containing up to 2 wt % Eu were successfully rolled with a maximum reduction of 60 to 80% in two passes with process annealing at 850°C for 30 min. Alloys containing up to 8.03 wt % Eu sustained a 16% reduction in height with upsetting at room temperature. Parts of various configurations were obtained from alloys with up to 2% Eu cold-deformed with vacuum process annealing. A series of Ce alloys containing 0 to 76.5 wt % Eu were melted from 99.5%-pure Ce in a vacuum induction furnace, and a tentative phase diagram of the Ce–Eu system was plotted. The phase diagram is characterized by a continuous solubility of high-temperature modifications of δ-Ce and Eu and by a wide region of solubility of γ-Ce in Eu. Vacuum annealing at 400 and 600°C for 200 hr decreased the hardness of Ce-Eu alloys and led to grain growth. Ce-Eu alloys containing up to 10 to 20 wt % Eu appeared to have a single-phase structure; the structure of the alloys containing more than 40 wt % Eu was not determined. Ho alloys containing 0 to 49 wt % Eu had a single-phase structure which was only slightly affected by annealing at 600°C for 150 hr. The Ho-Eu alloys are characterized by good solubility of these metals in each other in both liquid and solid states. A difference in the crystal lattices of these metals makes it possible to assume the existence of intermediate phases in the Ce-Eu system. An alloy of Yb with 30 wt % Eu had a hardness of 22 kg/mm². The hardness of an alloy of Ca with 12 wt % Eu was 30 kg/mm². Analogous properties make it possible to substitute ultrarare and expensive Eu with Ca as a model in preliminary investigations of interaction between Eu and other elements. (ATD)

30985 FACTORS AFFECTING THE ADHESION OF TITANIUM AND MOLYBDENUM COUPLES. Johnson, K. L.; Keller, D. V. Jr. (Syracuse Univ., N. Y.). J. Vac. Sci. Technol., 4: 115-22(May-June 1967).

Metallic-adhesion experiments reported in the literature have shown that softer metal couples could weld more easily than harder, and that metal couples of hexagonal atomic structure are more difficult to weld than those of cubic structure. Because of the presence of contamination in all of these studies, however, it has not been clear whether these tendencies are intrinsic properties of the metals or simply due to a difference in the sensitivity of these materials to such contamination. Previous studies by the authors have shown that the principal barrier to adhesion between soft metals at room temperature is due solely to contamination. This work is presently extended to a metal of high hardness, a Mo–Mo adhesion couple, and to a couple of hexagonal atomic structure, Ti–Ti. Both metal couples were found to be most difficult to prepare with ultraclean surfaces; however, when this was accomplished, cold welding was observed at room temperature to approximately one-half the bulk strength of titanium and one-quarter of the bulk strength of molybdenum, respectively. The greater difficulty encountered when pressure welding harder metals or couples of hexagonal atomic structures was shown to be due to contamination effects, and is not an inherent property of these materials. A few atomic layers of contaminant are sufficient to prevent adhesion of these metals under lightly loaded conditions. Contact resistance has been demonstrated as a useful tool for the estimation of the degree of cleanliness of the metal surfaces. (auth)

30986 FILM DEPOSITION BY EXPLODING WIRES. Mattox, D. M.; Mullendore, A. W.; Rebarchik, F. N. (Sandia Corp., Albuquerque, N. Mex.). J. Vac. Sci. Technol., 4: 123-7(May-June 1967).

The exploding-wire phenomena provide a high flux of high-energy atoms incident on a surface. Electron-microscopy studies of the nucleation and growth of films formed by exploding wires in vacuum show no deviation from the typical island-channel stages of growth commonly observed in vacuum-deposited and sputter-deposited films. Observations of the deposited material give some insight into the physical processes occurring in the expanding vapor cloud from the exploding wire. Applications and limitations of this technique for depositing thin films are discussed. (auth)

30987 HIGH TEMPERATURE NIOBIUM BASE ALLOYS. (to United Aircraft Corp.). British Patent 1,065,100. Apr. 12, 1967. Priority date Dec. 21, 1962, United States.

Processing methods were developed, for a variety of Nb-base alloys, to achieve an optimum balance between low-temperature ductility and high-temperature strength. Cast alloy ingots were reduced in cross section 33 to 80% in primary fabrication at temperatures of 982 to 1649°C. The alloy specimens were then annealed at 1204 to 1649°C for 1 hour to substantially complete recrystallization or recovery, thereby eradicating work-hardening introduced during initial fabrication. For final fabrication the specimens were encapsulated in steel or Mo pack assemblies, reheated and rolled. Final rolling was accomplished at reductions of 10% in each pass, the assemblies being reheated after each pass. Finally the strips were cleaned by pickling and grinding and stress-relieved by annealing at 1204°C under vacuum of 0.1 mm Hg for ½ hour. Nb-base alloys which may be processed by this method comprise those containing Mo, Ta, V, and W. (P.G.C.)

Properties Evaluations

Refer also to abstracts 30390, 30401, 30957, 30963, 30967, 30974, 30984, 31036, 31038, 31944, and 32060.

30988 (AD-644650) THE EFFECT OF SIMULATED FISSION PRODUCTS IN THE INTER-ELECTRODE SPACING OF A THERMIONIC DIODE. Annual Report No. 2, November 1, 1965–October 31, 1966. Davis, Monte V.; Britt, E. J.; Turner, D. M. (Arizona Univ., Tucson. Engineering Experiment Station). Dec. 17, 1966. Contract Nonr-2173(13). 21p. CFSTI $3.00 cy, $0.65 mn.

The effect of I impurities on the Ta emitter of a diode are shown photographically. The development of the Mark III and IV systems are shown, and the preliminary experiments on the vapor deposited W surfaces are discussed. (auth)

30989 (AERE-M-1471) STRENGTH OF METALS UNDER RAPID LOADING: A SURVEY IN RELATION TO THE DIDO 4H5 LIQUID-HYDROGEN LOOP CONTAINMENT VESSEL. Gracie, P. S. (Atomic Energy Research Establishment, Harwell (England)). Sept. 1965. 17p. Dep. CFSTI.

Brief summaries of the reactions and phenomena occurring in metal vessels subjected to explosive pressurizing are given. Factors reviewed include pressures developed in contained explosions, energy of rupture, time of pressure transients, response of various metals to dynamic loading, explosive hardening, and use of scleroscopic and impact methods to secure information regarding high-speed yield and strength of metals. Thirty references are cited. (P.G.C.)

30990 (AGN-8224) EVALUATION STUDY OF HASTELLOY X AS A NUCLEAR CLADDING. Quarterly Progress Report, January 1–March 31, 1967. (Aerojet-General Corp., San Ramon, Calif. Nuclear Products and Services Group). May 1967. Contract AT(04-3)-368. 95p. Dep. CFSTI.

A duplex oxide film was formed on Hastelloy X at all exposure temperatures. The outer layer was found to be rich in Mn and Cr

($MnCr_2O_4$); the inner layer is composed largely of Cr (Cr_2O_3). The carbide particles present in exposed Hastelloy X were analyzed by point-counting techniques. The data indicated that the composition of the carbide varies between $M_{3.5}C$ and $M_{15}C$. Metallographic examination of low-Co and commercial tubing exposed for 7500 hr at 1900 and 2000°F was completed. Corrosion in the low-Co tubing was largely by internal oxidation. A major depleted zone was detected in the commercial material. Room-temperature tensile testing of sheet and tubing exposed at 1900°F revealed a general reduction in ultimate and yield strength as a function of exposure duration. Elongation properties of the sheet material varied only slightly as a function of exposure time. Data from an 1800°F, 1000 hr centrifugal creep test of 4 Hastelloy X heats in air were analyzed. In specimens where the total strain was less than 1%, a linear relationship existed between strain and time. (M.C.G.)

30991 (BNWL-210) UNFOLDING PARTICLE SIZE DISTRIBUTIONS. Nicholson, W. L.; Merckx, K. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1967. Contract AT(45-1)-1830. 60p. Dep. CFSTI.

The estimation of a particle-size distribution from a data histogram is treated in terms of a general framework that extends previous developments. The method, at least in principle, can be applied to any complex particle that can be sized in terms of a single characteristic dimension. A sectioning or sampling process must be used to produce a particle intersection that can also be sized with a single characteristic measurement. The precision of the process is estimated with a standard deviation estimate for each particle size in the distribution. The method can be used to estimate distribution of sizes of voids induced by fission gases in irradiated U. A FORTRAN IV program called UNFOLD, for analysis of the frequency data collected on a particle-size analyzer, is presented. (M.C.G.)

30992 (COO-1477-8) FRACTURE TOUGHNESS OF REACTOR PRESSURE VESSEL STEELS. DEVELOPMENT OF TEST PROCEDURES. [Period Covered]: February 1-April 30, 1967. Ripling, E. J.; Crosley, P. B. (Materials Research Lab., Inc., Richton Park, Ill.). May 31, 1967. Contract AT(11-1)-1477. 14p. Dep. CFSTI.

Fracture toughness tests were made on reactor pressure vessel steels as a function of loading rate at ambient (75°F) and 0°F. The specimens were 1 and 2 in. thick with side-groove ratios that varied from $b_n/b = 0.50$ to 0.75. The cracking plane was parallel to the plate surface and located on the midplane of the 4 in. thick A302 steel plate. It was tentatively concluded that loading rate exerts only a modest influence on toughness over the range studied. On the other hand, rapid loading rates appeared to promote plane strain fracturing. It was also concluded that the measuring capacity of fracture toughness specimens could be increased by the use of very high loading rates. (P.C.H.)

30993 (EURAEC-1825) IN-PILE CORROSION OF NUCLEAR MATERIALS. Quarterly Report No. 6, September 1, 1966-November 30, 1966. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Contract 055-65-3TEEB(RD). 41p. (EUR-3354). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

The radiolysis of aqueous solutions was followed by recording the potential E_{Pt} of Pt versus a Ag/AgCl reference electrode during and after γ irradiation. Then the influence of these radiochanged solutions on steel electrodes was measured by recording the open-circuit potential E_{SS} versus time. Widely varying corrosion conditions were thus obtained. Work has been extended to measurements on steel during γ irradiation and at higher temperature and to neutron irradiation experiments on the solutions as well as on the steel electrodes. Potentiokinetic polarization curves in γ irradiated solutions served to locate the regions of activity and passivity. Another studied variable has been the velocity of the solution. Static and dynamic tests have been compared. Systematically all the results and data obtained are presented, but without any interpretation. (auth)

30994 (EURAEC-1842) STUDY OF FISSION GAS RELEASE FROM UO_2 SAMPLES IRRADIATED AT VARIOUS DOSES. Quarterly No. 5, October-December 1966. Baffigo, V.; Gerevini, T. (comps.) (Societa Ricerche Impianti Nucleari, Saluggia (Italy). Centro Ricerche Nucleari). Feb. 1967. Contract 043-65-TEEI (RD). 9p. (EUR-3359). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

Eleven diffusion experiments were performed at 1400°C on fused powder, fused grain, and hot-pressed grain. Data are presented in tables. (M.C.G.)

30995 (GAMD-7525) CESIUM PLATEOUT ON STAINLESS AND CARBON STEELS. Milstead, C. E.; Zumwalt, L. R. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Oct. 25, 1966. Contract AT(04-3)-167. 24p. Dep. CFSTI.

Studies indicated that the degree of plateout of cesium on steel surfaces is primarily dictated by the thickness of the oxide film on the steel. Thus, a relatively "oxide free" surface is desired to maintain a low level of cesium plateout to minimize maintenance, decontamination, and shielding of reactor components. Cesium plateout studies using the isopiestic method indicated an empirical isotherm, which provides a useful means for evaluating plateout characteristics of metal surfaces for Cs. Only a few experimental points are necessary for developing appropriate isotherms that can then be extrapolated to the desired low Cs pressures. However, the behavior of the Cs-steel system was not investigated at Cs pressures below 10^{-9} atm, and extrapolated values for very low pressures are necessarily uncertain. (auth)

30996 (LA-3678) ONE-DIMENSIONAL ELASTIC-PLASTIC CALCULATIONS FOR ALUMINUM. Mader, Charles L. (Los Alamos Scientific Lab., N. Mex.). Feb. 14, 1967. Contract W-7405-eng-36. 23p. Dep. CFSTI.

Experimental measurements of the free-surface velocity of Al targets being shocked by flying Al plates moving at 0.10 and 0.041 cm/μsec are used to calibrate the Hooke's law-Von Mises yield model of elastic-plastic flow for Al at 33 and 84 kbar. (auth)

30997 (LA-DC-8675) METALLOGRAPHY OF HYPO-, HYPER-, AND STOICHIOMETRIC SINTERED (U,Pu)C. Bender, J. H. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 10p. (CONF-670533-1). Dep. CFSTI.

From 21st AEC Metallographic Group Meeting, Upton, N. Y.

Procedures for the metallographic preparation of hypo-, hyper-, and stoichiometric sintered $(U_{0.8}Pu_{0.2})C_x$ samples are described. These include cutting, mounting, grinding, and polishing techniques as well as chemical and electrolytic etching for optical and electron microscopy. (auth)

30998 (LA-DC-8790) AN EVALUATION OF THE HEAT OF VAPORIZATION OF URANIUM FROM THE BEHAVIOR OF THE U-C SYSTEM. Storms, Edmund (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 16p. (CONF-670527-1). Dep. CFSTI.

From International Symposium on High Temperature Chemistry, Argonne, Ill.

The heat of evaporization behavior of pure U has not been deduced by direct measurements. An evaluation of the heat of vaporization of U from the behavior of the U-C system is given. Some direct vapor pressure measurements have been made in the U-C system. (J.C.W.)

30999 (ORNL-3795) A BIBLIOGRAPHY ON TRACER DIFFUSION IN METALS. SUPPLEMENT II. PART I. SELF-DIFFUSION IN PURE METALS. PART II. IMPURITY DIFFUSION IN PURE METALS. PART III. SELF AND IMPURITY DIFFUSION IN ALLOYS. Askill, John (comp.) (Oak Ridge National Lab., Tenn.). June 1967. Contract W-7405-eng-26. 11p. Dep. CFSTI.

Frequency factors, activation energies, and other data for self and impurity diffusion in pure metals and alloys were compiled from the literature reported between December 1965 and December 1966. (31 references). (M.C.G.)

31000 (ORNL-4141) NEAR-SURFACE DIFFUSION ANOMALY IN GOLD. Mortlock, A. J. (Oak Ridge National Lab., Tenn.). July 1967. Contract W-7405-eng-26. 16p. Dep. CFSTI.

Co and Ni have been diffused at tracer concentrations in Au at several temperatures in the range from approximately 700 to 950°C. The diffusion penetration profiles were determined by a serial sectioning technique in which the Au is first anodized and then the anodic layer is dissolved in acid. In this way sections as thin as 250 A could be removed reproducibly. In all cases, the region close to the specimen surface was characterized by irregular behavior in the sense that the logarithm of concentration was not linear in the square of the penetration distance. In some cases, there was an indication of the operation of very slow diffusion in this region, while in others the apparent diffusion coefficient was negative. Possible reasons for this anomalous behavior are briefly discussed. (auth)

31001 (ORNL-TM-1755) PRELIMINARY COLLATION OF THE THERMODYNAMIC AND TRANSPORT PROPERTIES OF CESIUM. Hoffman, H. W.; Robin, T. T. Jr. (Oak Ridge National Lab., Tenn.). June 1967. Contract W-7405-eng-26. 66p. Dep. CFSTI.

A preliminary collation of the thermodynamic and transport properties of saturated liquid and vapor Cs and a convenient and consistent source of properties in the design and evaluation of

power systems based on thermodynamic cycles involving Cs as the working fluid are presented. Included are the thermodynamic properties—physical constants and critical state conditions, sonic velocities, PVT relationships (vapor pressure, density, and compressibility), enthalpy, heat capacity, latent heat of vaporization, and entropy, and surface tension—and the transport properties—viscosity, thermal conductivity, and electrical resistivity. A preliminary evaluation of the data available indicates the need for additional measurements of both the thermodynamic and transport properties. Thus, for liquid enthalpy, the differences between the tabulated relations, while small, are sufficient to affect significantly thermodynamic cycle calculations. To a lesser extent further data on the PVT characteristics would be useful, since these data are the base for the calculation of vapor enthalpies. Vapor pressures for temperatures above 1950°F are reported. Measurements of the latent heat of vaporization are reported and show reasonable agreement with the experimental values. The surface tension has been obtained; experiments are in progress, and evaluation of need for further studies must await the outcome of these current investigations. In respect to the transport properties, serious disagreements exist for vapor viscosities and thermal conductivities; and the need for additional measurements is evident. Some variation, though not as significant, exists for the liquid viscosities and conductivities. (auth)

31002 (ORNL-TM-1802) MECHANICAL PROPERTIES OF Al–Al_2O_3 ALLOYS: TESTING PROCEDURES AND EVALUATION OF DATA. Harman, D. G. (Oak Ridge National Lab., Tenn.). May 1967. Contract W-7405-eng-26. 14p. Dep. CFSTI.

Techniques have been developed to evaluate the elevated-temperature mechanical properties of Al–Al_2O_3 (SAP-type) alloys. Varying the strain rate over two orders of magnitude has explained much of the reported scatter in mechanical property data and provided data for creep-rupture predictions. The strain rate $\dot{\epsilon}$, in SAP is an exponential function of the stress σ: $\dot{\epsilon} = A\,\sigma^n$ with n being very high. This high n value is correlated with short-time tensile and creep-rupture behavior. Fractographic analysis shows ductile fracture under all testing conditions. (auth)

31003 (RFP-933) TENSILE PROPERTIES OF GAMMA QUENCHED AND AGED URANIUM-RICH NIOBIUM ALLOYS. Jackson, Ross J.; Brugger, Ronald P.; Miley, Delmar V. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). June 2, 1967. Contract AT(29-1)-1106. 15p. Dep. CFSTI.

Tensile-test data are presented for U-rich Nb alloys containing 11, 15, 17, and 19 at. % Nb in both the solution-quenched and the aged conditions. The tensile-test data are correlated with concurrent metallographic and x-ray studies. The results show that a wide variety of mechanical properties are available from these heat-treatable, corrosion-resistant, high-density alloys. (auth)

31004 (SC-RR-66-325) DYNAMIC CRUSHUP OF FOAMS. Butcher, B. M. (Sandia Corp., Albuquerque, N. Mex.). May 1967. Contract AT(29-1)-789. 65p. Dep. CFSTI.

A study was made of the present concepts of foam compaction under shock loading. An appraisal was made of existing models of foam response with regard to the extent that known properties of the solid material may be used to predict the properties of the material in a distended state. A brief survey was made of the details of the Hugoniot theory peculiar to foams. The way Fritz and Taylor described the response of adiprene rubber is given, which illustrates how easily determined quasi-static crushup properties of the material may be useful in predicting dynamic behavior. The plate-gap model suggested by Thouvenin is developed in detail and compared with results obtained from direct application of the Hugoniot equations. The comparison shows that the plate-gap model does approximately predict the relation between shock velocity and free-surface velocity at high pressures for low-density metal forms. (auth)

31005 (UCID-15141) CONTRIBUTIONS TO THE 1967 US/UK PLUTONIUM NEWSLETTER. (California Univ., Livermore. Lawrence Radiation Lab.). May 15, 1967. Contract W-7405-eng-48. 9p. Dep. CFSTI.

Ductility-temperature curves and maximum torque-temperature curves are shown for both the nominal-purity alloy and the high-purity alloy (Pu–1.06 wt % Ga and 231 ppM total metallic impurities). Both alloys exhibited a ductility transition region between 150 and 250°C, which led to "unlimited ductility" between 200 and 500°C. There was a drastic loss of ductility above these temperatures. Torque decreased rapidly with increasing temperature. Phase studies were made of the Pb–Pu system. The prominent feature of the liquidus is the miscibility gap extending from approximately 40 to 85 at. % Pu. Four of the 6 compounds detected lie under this syntectic horizontal. (M.C.G.)

31006 (WAPD-TM-560) PROCEDURE FOR THE FATIGUE EVALUATION OF DEFECTIVE PIPE BUTT WELDS. McGowan, E. J.; Snow, A. L. (Bettis Atomic Power Lab., Pittsburgh, Pa.). May 1967. Contracts NObs-90029; AT-11-1-GEN-14. 33p. Dep. CFSTI.

An evaluation procedure for determining the acceptability of a weld joint containing defects and subjected to cyclic loading is presented. A method of classifying different types of defects is given and the δ concept of notched fatigue damage is used to assign fatigue strength reduction factors to the different types of defects. The calculation of peak stresses is discussed and determination of stress differences for fatigue evaluation is outlined. Form sheets are included to facilitate the efforts required by the procedure. (auth)

31007 (ORNL-tr-1689) RELAXATION OF THE PRESTRESSING CABLES ON THE G2 AND G3 NUCLEAR REACTOR VESSELS. Segot, M. Translated by Gregory L. Boisvert (Oak Ridge National Lab., Tenn.), from Ann. Inst. Tech. Batiment Trav. Publics, 17: No. 203, 1270-2(Nov. 1964). 12p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Measurements of the relaxation of the prestressing cables on the Marcoule G-2 and G-3 Reactors indicate the decrease in tensions is at no particular site. The measurements made during reactor operation indicate also the decrease found is slightly greater than had been anticipated from studies of previous structures. (J.C.W.)

31008 (ORNL-tr-1702) MASS-SPECTROMETRIC INVESTIGATION OF THE DEGASSING OF MOLYBDENUM, TUNGSTEN AND NIOBIUM WHEN HEATED IN A VACUUM. Ryabchikov, L. M. Translated for Oak Ridge National Lab., Tenn., from Ukr. Fiz. Zh., 9: 293-302(1964). 17p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The vacuum heating of Mo, W, and Nb to temperatures above 1000°C causes a reduction in their H_2, O_2, and C content as a result of the degassing of H_2 and CO. The rate of H_2 release was determined by its diffusion. For the diffusion coefficients of hydrogen the following expressions were obtained: in Mo, $D = 0.158e^{-(22200/RT)}$; in W, $D = 0.081e^{-(19800/RT)}$; and in Nb, $D = 0.056e^{-(19200/RT)}$. In the case of a fine-grained, textured structure, the degassing rate from Mo was higher than could be accounted for by diffusion. This is related with the motion of H_2 along the grain boundaries. The degassing rate for CO greatly exceeded the diffusion rates of C and O_2 in the investigated metals; this is caused by the predominant distribution of carbide and oxide phases along the grain boundaries and the boundary diffusion of C, O_2, and CO. The diffusion coefficient of O_2 in Nb at temperatures in excess of 2000°C were determined from the release rates in O_2. (auth)

31009 (TT-66-51150) HANDBOOK OF BINARY METALLIC SYSTEMS. STRUCTURE AND PROPERTIES. VOLUME II. PHYSICOCHEMICAL PROPERTIES OF THE ELEMENTS. SYSTEMS OF BISMUTH, DYSPROSIUM, EUROPIUM, GADOLINIUM, GALLIUM, GERMANIUM, HAFNIUM, HOLMIUM, HYDROGEN, IRON, TUNGSTEN, AND VANADIUM. Vol, A. E. Translation of Stroenie i Svoistva Dvoinykh Metallicheskikh Sistem. Tom 2. Sistemy Vanadiya, Vismuta, Vodoroda, Vol'frama, Gadoliniya, Galliya, Gafniya, Germaniya Gol'miya, Dispoziya, Evropiya, Zheleza, Moscow, 1962. 888p. (IPST-Cat.-1712). CFSTI.

Data are given on phase diagrams, crystal structures, and physical and chemical properties of binary alloys and systems of the elements Bi, Dy, Eu, Gd, Ga, Ge, Hf, Ho, H, Fe, W, and V. References were reviewed up to and including 1958 for Soviet publications, and up to and including 1957 for publications that have appeared outside the Soviet Union. In several cases when the preparation of the alloys of a given system presents technical difficulties, the working procedure to be adopted for the purpose is described. (P.C.H.)

31010 (UCRL-Trans-10103) ACTIVATION ENERGIES FOR DIFFUSION AND DIFFUSION COEFFICIENTS OF OXYGEN AND NITROGEN IN MOLYBDENUM. Ying-liang, Ma; Jiu-yih, Son. Translated by J. S. Bradley for Univ. of California Lawrence Radiation Lab., Livermore, from Chin Shu Hsueh Pao, 7: 68-76 (1964). 24p. Dep. CFSTI. JCL $2.60 fs, $0.92 mf.

Studies were made on internal friction peaks in Mo, and evidence is given to support the thesis that these peaks owe their origin to stress-induced microdiffusion of O or N. The internal friction peaks observed in the vicinity of 115 and 160°C were found to be result of microdiffusion of O and N in Mo, and the activation energies for the diffusion process were 25.2 and 28.5 kcal/mole. The fact that the internal friction peak height was found to be directly proportional to the oxygen or N concentration in solid solution showed that it is an O or N atom that directly participates in the primary jump in the stress-induced diffusion process. The fact that the height of the 200°C internal friction peak was quadratically related to the concentration showed that two O atoms are associated with the basic process. (P.C.H.)

31011 (WAPD-Trans-55) VALIDITY OF THE METHODS OF CALCULATION OF PLATES PERFORATED WITH NUMEROUS HOLES. Tran-Huu-Hanh (Ecole Nationale Superieure de Mecanique, Nantes (France)). Translated for Bettis Atomic Power Lab., West Mifflin, Pa., from the 1966 Annals. 40p. Dep. CFSTI. JCL $3.60 fs, $1.40 mf.

Methods of calculation of the strains and deformations tube plates in heat exchangers and reactors undergo under given loads are examined. The perforated plates can be replaced by a full plate of the same dimensions and two ways of carrying out the transformations are investigated. The method of bonding and deflection coefficients is not very rigorous and does not lead to a precise analysis of strains and deformations. The method of equivalent elastic constants gives only partially satisfactory results. (J.C.W.)

31012 STRUCTURE AND PROPERTIES OF BERYLLIUM–LANTHANUM ALLOYS. Nagorskaya, N. D.; Molchanova, L. V.; Novoselova, A. V.; Fridlyander, I. N.; Yatsenko, K. P.; Rogova, L. K. Metalloved. Term. Obrabotka Metal., No. 2, 37-9(Feb. 1967). (In Russian).

Crystallization of Be alloy containing up to 53.5% La, cooled from the melted state to 300 to 400°C for 15 to 20 min, was investigated. The alloys were induction-melted from 99.5%-pure Be and extra-pure La in Ar or He atmosphere. A significant amount of eutectic was observed in alloy containing 1% La. Alloy with 2% La had a eutectic composition. The hardness of alloys increased with increasing La content from 98 HV for pure Be to 518 HV for alloy with 52.22% La and 555 HV for intermetallic compound $LaBe_{13}$ (54.24% La). Alloys containing 1, 3, 10, and 15% La had a room-temperature tensile strength of 27, 28, 22, and 21 kg/mm², and an elongation of 0.8, 1.6, 2.5, and 0.4%, respectively. Corresponding figures for the same alloys tested at 500°C were 18, 18, 20, and 21 kg/mm² and 23, --, 6.4, and 1.9%. (ATD)

31013 DUCTILITY OF ALUMINUM–BERYLLIUM ALLOYS. Fomin, K. N.; Fridlyander, I. N.; Yatsenko, K. P.; Bakhurina, Z. N.; Nekrasova, G. A. Metalloved. Term. Obrabotka Metal., No. 2, 39-42(Feb. 1967). (In Russian).

Two complex alloyed Al–Be base alloys, 1 and 2, containing between 20 and 50% Be (exact composition unidentified) were tested primarily for ductility at 250 to 500°C. Alloy 1 had a room-temperature tensile strength of 41 to 48 and 50 to 55 kg/mm² and an elongation of 15 to 20 and 11 to 18% in the as-extruded and as-rolled conditions, respectively. Corresponding values for alloy 2 were 42 to 48 and 50 to 53 kg/mm² and 20 to 24 and 15 to 24%. The modulus of elasticity of alloy 1 was 13,500 kg/mm²; that of alloy 2 was 11,500 kg/mm². Alloy specimens cut from bars extruded with a reduction of 80% were subjected to compression, tensile and notched-bar-impact tests. Alloy 2 was found to have a ductility generally lower than that of wrought Al alloys but higher than that of alloy 1. The optimum temperature of plastic deformation was found to be 380 to 470°C and 350 to 400°C for alloys 1 and 2, respectively. The relatively low ductility of the alloys is apparently a result of a heterogeneous structure. At room temperature, the microstructure consists of a Be-base solid solution and eutectic, the latter containing up to 98.5% Al. With temperature increased above 250°C, the eutectic grains of alloy 1 begin to grow and some of the components accumulated along the grain boundaries begin to dissolve. No grain growth with increasing temperature was observed in alloy 2, which had a higher Be content than alloy 1. The structural components of both alloys differed considerably in hardness and ductility. Therefore, care must be exercised in plastic working of both alloys. Both alloys should be worked in the optimal ranges of plastic deformation with a maximum reduction of 30 to 50% between process annealing. Under these conditions they can be extruded, rolled and upset (the latter only in hydraulic presses). The alloys are not toxic and can be processed in the same shops with the same equipment used for processing standard Al. (ATD)

31014 PHYSICAL AND MECHANICAL PROPERTIES OF ALLOYS OF THE Ti–Nb–V SYSTEM. Kalinin, G. P.; Elyutin, O. P. (Central Scientific-Research Inst. of Non-Ferrous Metals, Moscow). Metalloved. Term. Obrabotka Metal., No. 2, 15-17(Feb. 1967). (In Russian).

Ternary Ti–Nb–V alloys containing up to 50% Nb and up to 45% V were melted from electrolytic Ti, Nb with a total content of 99.1% Nb and Ta, and 94.1%-pure V containing 4.8% Al. The alloys were arc melted in an Ar atmosphere, annealed at 1100 to 1200°C for 15 to 25 min, forged and then machined into rods, 7 mm in dia/150 mm long, which were vacuum annealed at 700°C for 2 hr and furnace cooled. Ternary alloys located within the region of binary Ti-(35 to 40%)Nb and Ti-(24 to 30%)V alloys had extremum values of electric resistivity, 0.95 to 1.21 μohm/m. Ternary alloys with the lowest temperature coefficient of electric resistivity ($0.2 \cdot 10^{-3}$/°C) were in the region between Ti–V alloys with 29 to 35% V and Ti–Nb alloys with 38 to 43% Nb. Ternary alloys containing 25 to 32% V and up to 5% Nb located at the Ti–V side of the concentration triangle had the lowest heat conductivity (0.019 cal/cm/sec/deg). Similar to binary Ti–Nb and Ti–V alloys, the modulus of elasticity of ternary Ti–Nb–V alloys decreased with increasing content of Nb and V to a summary content, and then increased with a further increase in the Nb and V content. In general, binary and ternary alloys which had the highest electric resistivity had the lowest values of the temperature coefficient of electric resistivity and the lowest thermal emf and modulus of elasticity. The alloys with extremum physical properties were in the $\alpha + \beta$ region along the $\alpha + \beta/\beta$ phase-transformation boundaries. Ternary alloys in the region between binary Ti–V alloys with 12 to 18% V and Ti–Nb alloys with 30 to 35% Nb had the highest tensile strength (92 to 97 kg/mm²) at an elongation of 10 to 18%. In Ti alloys with 25 to 40% V and a low Nb content, the tensile strength reached 143 kg/mm², probably because of increasing content of Al, O_2, and N_2 impurities in alumothermic V. The most ductile alloys, with a tensile strength of 51 to 82 kg/mm² and an elongation of 10 to 14%, were binary Ti–Nb alloys with 45 to 55% Nb and a number of ternary Ti–Nb–V alloys containing 30 to 55% Nb and up to 10 to 15% V. (ATD)

31015 POSITIVE AND NEGATIVE SELF-SURFACE IONIZATION OF TUNGSTEN AND RHENIUM. Scheer, Milton D.; Fine, Joseph (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 46: 3998-4003(May 15, 1967).

The self-surface ionization of tungsten and rhenium has been investigated with a specially designed mass spectrometer. It has been found that both positive and negative singly charged atomic ions sublime from these metal surfaces in the 1900° to 2600°K temperature range. The assumption that these processes can be described by a generalized Saha–Langmuir equation has been shown to be valid. The energies required for positive-ion sublimation were found to be 12.1 and 10.7 eV for tungsten and rhenium, respectively. The negative-ion sublimation energy for rhenium was determined as 12.6 eV and that for tungsten is given by approximately the same value. At 2300°K, the ratio of positive to negative ions evaporating from these surfaces was found to be about 40 for tungsten and about 20,000 for rhenium. These results are consistent with the following estimates for the electron affinities: A(W) = 0.50 ± 0.30 eV and A(Re) = 0.15 ± 0.10 eV. (auth)

31016 COMPOSITION AND STRUCTURE OF NICKEL LAYERS DEPOSITED ON NIOBIUM. Bulatov, A. S.; Vasyutinskii, B. M.; Kartmazov, G. N.; Kogan, V. S.; Yakimenko, L. F. (Physico-Technical Inst., Kiev). Fiz. Metal. Metalloved., 23: 380-1(Feb. 1967). (In Russian).

The composition of a vapor-deposited Ni layer on a Nb substrate has been investigated. The deposition of Ni was carried out at a rate of 15 or 0.5 μ/hr for 10 hr and a substrate temperature of 700 to 1100°C. Metallographic and x-ray diffraction analysis show that the deposited layer consisted of pure Ni and a solid solution of Nb in Ni if the temperature of deposition was higher than the temperature of the substrate. An intermetallic compound of NbNi and $NbNi_3$ formed an interlayer between Ni and Nb. The coefficient of Nb diffusion into Ni, determined during annealing of specimens at 1000°C, was 1.3×10^{-10} cm²/sec. In the case when the temperature of the Nb substrate was higher than the temperature of the Ni, the deposit consisted of layers of NbNi and $NbNi_3$ compounds. The amount of the NbNi layer increased with increasing substrate temperature and reached 100% at 1000°C and a deposition rate of 0.5 μ/hr. The NbNi phase had a hexagonal structure with lattice parameters: a = 4.895 ± 0.003 Å and c = 26.62 ± 0.01 Å. (ATD)

31017 INVESTIGATION OF TERNARY W–Mo–Re ALLOY WITH ELECTRON AND ION PROJECTORS. Kuznetsov, V. A.; Makukha, V. I. (Moscow Physical-Technical Inst.). Fiz. Metal. Metalloved., 22: 281-4(Aug. 1966). (In Russian).

Field-emission and hydrogen ion microscopes were used in investigation of the ternary alloy of 53 wt % W, 17 % Mo, and 30% Re. The points were prepared by electrolytic etching in a normal solution of NaOH by an ac current at 2 to 3 V. Specimens of wires 0.15 mm in diameter annealed for 1 hr in 1400°C in ~10^{-4}mm Hg vacuum were used in the experiments. Autoelectron images of the alloy are presented. (R.V.J.)

31018 DIFFUSION OF ALKALI METALS INTO MOLYBDENUM AND NIOBIUM. Karpman, M. G.; Shcherbedinskii, G. V.; Dubinin, G. N.; Benediktova, G. P. (Central Scientific-Research Inst. of Non-Ferrous Metallurgy, Moscow). Metalloved. Term. Obrabotka Metal., No. 3, 46-9(Mar. 1967). (In Russian).

The diffusion of K and Na in mono- and polycrystalline specimens of Mo at 800 to 1100°C and in Nb at 900 to 1100°C was in-

vestigated, using ^{24}Na and ^{42}K as tracers. Molten chlorides and the liquid metals were used as the media for saturating the refractory metals. The diffusion coefficients obtained were quite close to each other. The concentration distribution of the alkali metals was determined by radiometric analysis. It was found that the surface hardness of both metals was somewhat increased by the diffusion of the alkali metals. The diffusion rate into Mo was lower than Nb; this is probably due to the large lattice parameters of the latter and the higher melting point of Mo. The diffusion coefficient of K into both metals was lower and the energy of activation was higher than the corresponding values for Na; this may be attributed to the higher radius of the K atom. The diffusion coefficients involving single crystals were lower than those obtained with polycrystalline specimens. It was concluded that the diffusion follows the path of the grain boundaries. (TTT)

31019 CREEP PROPERTIES OF REFRACTORY METAL ALLOYS IN ULTRAHIGH VACUUM. Sawyer, J. C.; Steigerwald, E. A. (TRW Inc., Cleveland). J. Mater., 2: 341-61(June 1967).

Creep tests were conducted on selected refractory alloys in a vacuum environment (1×10^{-6} to 1×10^{-10} torr) for times approaching 10,000 hr. Particular emphasis was placed on measuring creep extensions below 1%. In arc-cast W tested at 2800 to 3200°F, the strengthening effect produced by Re alloying was only apparent at applied stress levels >1000 psi. Considering the W-base alloys, the material containing Hf and C possessed the greatest degree of creep strength. The Mo-base alloys TZM and TZC, the Nb-base alloys AS-30 and Cb132M, and the Ta-base alloy T-222 were evaluated at 1800 to 2200°F. On a strength-to-weight basis, the TZC material had creep strength in the annealed condition (3092 F, 1 hr) that was significantly higher than the other materials. Experimental evidence indicated that the high creep strength of the TZC alloy in the annealed condition could be attributed to a strain-induced precipitate which occurred during the test. (auth)

31020 INFLUENCE OF DEFORMATION ON THE KINETICS OF RECRYSTALLIZATION OF NICKEL AND NIOBIUM MONOCRYSTALS. Zasimchuk, E. E. (Inst. of Metal Physics, Kiev). Fiz. Metal. Metalloved., 22: 306-7(Aug. 1966). (In Russian).

Recrystallization kinetics of Nb and Ni monocrystals were studied as a function of deformation by rolling. The studies were carried out with specimens prepared by electron-beam melting with cut out plates oriented at (102), (101), (315), and (111) planes for Ni and (111) and (101) for Nb. The plates were deformed by rolling at room temperature. Recrystallization annealing was carried out at 405 ± 2°C for Ni and 1030 ± 10°C for Nb. Graphs of parameters of recrystallization kinetics as function of deformation by rolling are included. (R.V.J.)

31021 DIFFUSION OF NIOBIUM WITH SOME HIGH-MELTING METALS. Prokoshkin, D. A.; Vasil'eva, E. V.; Bergasova, L. L. (Inst. of Metallurgy, Moscow). Metalloved. Term. Obrabotka Metal., No. 3, 44-6(Mar. 1967). (In Russian).

The correlation between the self-diffusion energy of activation and the melting and sublimation point, and expansion coefficients of metals indicates that the diffusion mobility is a function of interatomic forces. This problem was studied by investigating the interdiffusion of Nb and the Group IVa–VIa refractory metals, which form continuous solid solutions. Pairs of the metals were heated in a vacuum furnace to 1300 to 1800°C and the diffusion zone examined by x-ray-diffraction, metallographic, and microhardness measurements. It was confirmed that the mobility affected most strongly the high-temperature strength of the alloy. In every case, the lower-melting element diffused preferentially into the more refractory one. In some cases, pore formation was noted. Alloying Nb with a higher-melting element, such as Ta, W, or Mo resulted in reduction of the diffusion mobility and an increase in the energy of activation of self diffusion, and thus an increase in the interatomic bond strength in the solid solution. Alloying with lower-melting elements, (i.e., Ti, V, or Zr,) resulted in the corresponding weakening of the bond strength and an increase in the diffusion coefficient with respect to the self diffusion of pure Nb. (TTT)

31022 TENSILE STRENGTH OF NIOBIUM–MOLYBDENUM ALLOYS. Wyatt, B. S.; Argent, B. B. (Univ. of Sheffield, Eng.). J. Less-Common Metals, 13: 133-6(July 1967).

The effects of alloying on the temperature and strain-rate sensitivity of typical body-centered cubic metals such as Nb–Mo alloys were investigated. Conclusions concerning yield stresses, stress changes, activation volumes, and activation energies are presented. (J.R.D.)

31023 FIELD ION MICROSCOPE INVESTIGATION OF OXYGEN IN TUNGSTEN. Machlin, Eugene S. (Columbia Univ., New York). Amer. Soc. Metals, Trans. Quart., 60: 260-9(June 1967).

An investigation was made to elucidate the character of bright spots that appear in field ion-microscope patterns of W in the $(110)-(\bar{1}12)-(1\bar{1}2)$ triangular region. W wires were heat treated to vary their O content and tips made from these wires were examined in the field ion microscope. The bright-spot count in the referenced triangle varied monotonically with the heat treatment. It was concluded that the bright spots were images of O atoms in interstitial solution in the W lattice. Specimens similarly treated to contain C instead of O showed the smallest bright-spot count of all the specimens examined. It was concluded that either the C solubility limit at 2000°C is less than 10 ppM or that C is not visible in field ion-microscope patterns as an interstitial solute in tungsten. Association of O atoms during aging to form clusters and other interaction effects of solute atoms and defects were briefly studied. (auth)

31024 ANOMALIES OF THE TEMPERATURE DEPENDENCE OF YOUNG'S MODULUS OF NIOBIUM–ZIRCONIUM ALLOYS AND OF PURE NIOBIUM. Albert, Helmut; Pfeiffer, Irmtraud (Vacuumschmelze GmbH, Hanau, Ger.). Z. Metallk., 58: 311-16(May 1967). (In German).

In pure Nb and in Nb alloys containing 19 to 33 wt % Zr an anomalous temperature dependence of Young's modulus is found after heavy cold deformation. The bulk modulus decreases initially and increases sharply subsequently with increasing temperature. Annealing treatments at 600°C lead to a transition to the normal decreasing temperature dependence which is due to recovery in pure Nb and due to a decomposition of the β-phase in Nb–Zr alloys. By suitable heat-treatment of the alloys heterogeneous microstructures may be produced which exhibit areas of decomposition and areas with deformation and rolling texture in juxtaposition. Alloys which are treated in this way exhibit a large temperature range (approximately 0 to 200°C) with an anomalously small temperature dependence of Young's modulus. This effect may be ascribed to a superposition of the positive values of the temperature coefficient in the deformed areas and the negative values in the decomposed areas. Known results concerning an anomalous temperature dependence of Young's modulus of pure Nb after recrystallization which is due to a [110], [111] recrystallization texture, respectively, were corroborated. The corresponding anomaly characterized only by a smaller increase of Young's modulus with temperature, and [110], [111] recrystallization textures, respectively, are also found in Nb alloys containing 9.9 to 19 wt % Zr. In alloys with higher Zr contents [100]-recrystallization textures are observed and anomalous values of Young's modulus are not detected. It is shown that the anomalous effect after heavy cold deformation is independent of the rolling texture present and of the effect arising from the recrystallization texture. The reason for the anomaly after heavy cold deformation is thought to be due to the very high dislocation densities in Nb and Nb–Zr alloys and the temperature dependent interactions between dislocations on the one hand and impurity atoms on the other hand. (auth)

31025 STRENGTHENING MECHANISMS: METALS AND CERAMICS. Proceedings of the 12th Sagamore Army Materials Research Conference held at Sagamore Conference Center, Raquette Lake, New York, August 24–27, 1965. Burke, John J.; Reed, Norman L.; Weiss, Volker (eds.). Syracuse, N. Y., Syracuse University Press, 1966. 626p. $19.00. (CONF-650846).

Ten of the twenty-two papers included were abstracted for inclusion in NSA. The remaining 12 articles include information on: strength of ferrous martensites and the strengthening of steel by thermomechanical treatments; strain-hardening and creep mechanisms in ceramics; various innovations in strengthening mechanisms, and factors affecting the tensile strength of metals reinforced with strong fibers. (J.G.B.)

For abstracts of individual papers see: 31026–31030, 31074, 31075, and 31091–31093.

31026 STRUCTURE AND HIGH-STRENGTH METALS. Thomas, G.; Zackay, V. F.; Parker, E. R. (Univ. of California, Berkeley). pp 3-39 of Strengthening Mechanisms: Metals and Ceramics. Burke, John J.; Reed, Norman L.; Weiss, Volker (eds.). Syracuse, N. Y., Syracuse University Press, 1966.

From 12th Sagamore Army Materials Research Conference, Raquette Lake, N. Y., Aug. 24–27, 1965. See CONF-650846.

The plastic behavior of simple solids in terms of atomistic processes is summarized. Emphasis is on the relatively uncomplicated but important properties of strength and ductility. The limitations of the principal strengthening mechanisms are delineated and optimum procedures for achieving very high strength in complex solids are suggested. Some of the progress made to date in achieving these goals is reviewed. Since the literature concerned with structure and strength is so voluminous, typical bibliographical references are cited where appropriate. (J.G.B.)

31027 DISPERSION STRENGTHENING. Grant, Nicholas J. (Massachusetts Inst. of Tech., Cambridge). pp 63-82 of Strengthening Mechanisms: Metals and Ceramics. Burke, John J.; Reed, Norman L.; Weiss, Volker (eds.). Syracuse, N. Y., Syracuse University Press, 1966.

From 12th Sagamore Army Materials Research Conference, Raquette Lake, N. Y., Aug. 24–27, 1965. See CONF-650846.

The effects of structure on ductility of oxide dispersion-strengthened alloys are discussed. The trend currently is to the alloyed matrices rather than the pure metals; emphasis is on the oxidation-resistant alloys. Problems of oxide contamination, oxide stability at high temperatures, and oxide particle growth are reviewed. Examination of the potential among systems based on hard particles other than oxide is planned. (J.G.B.)

31028 ELECTRON CONCENTRATION AND METALLIC PROPERTIES. Abrahamson II, E. P. (Army Materials Research Agency, Watertown, Mass.). pp 291-315 of Strengthening Mechanisms: Metals and Ceramics. Burke, John J.; Reed, Norman L.; Weiss, Volker (eds.). Syracuse, N. Y., Syracuse University Press, 1966.

From 12th Sagamore Army Materials Research Conference, Raquette Lake, N. Y., Aug. 24–27, 1965. See CONF-650846.

The strengthening of metals by electron-concentration effects is shown by results of studies on phase diagrams, yield strength, grain-boundary hardness, lattice parameter, brittle-to-ductile transition, and recrystallization. The correlations observed indicate that in alloys one underlying mechanism, operating in several different ways, can be responsible for the changes in a series of properties, rather than there being a separate mechanism responsible for the effects on each individual property. (auth)

31029 FILAMENT-MATRIX INTERACTIONS IN METAL MATRIX COMPOSITES. Blackburn, L. D.; Burte, H. M.; Bonanno, F. R. (Air Force Materials Lab., Wright-Patterson AFB, Ohio). pp 447-75 of Strengthening Mechanisms: Metals and Ceramics. Burke, John J.; Reed, Norman L.; Weiss, Volker (eds.). Syracuse, N. Y., Syracuse University Press, 1966.

From 12th Sagamore Army Materials Research Conference, Raquette Lake, N. Y., Aug. 24–27, 1965. See CONF-650846.

The advent of high-modulus, high-strength filaments makes realistic the development of new composite materials using metal matrices, and thus affords an opportunity to extend the range of properties of these "tailor-made" materials beyond that available in the more familiar polymeric matrix composites. Since metal matrix composites will be exposed to elevated temperatures during synthesis and service, chemical-type interaction between matrix and filament may be an important factor controlling the properties of these materials. A wide variety of simple and complex interactions, ranging from simple solution of filament in the matrix to subtle interactions between matrix alloying elements or impurities and the filament materials are discussed. These interactions may have either beneficial or detrimental effects on composite strength, and could be a dominant factor in determining the success or failure of a particular matrix-filament combination to result in a sound structural composite. (J.G.B.)

31030 FIBER-METAL COMPOSITES. Weeton, J. W.; Signorelli, R. A. (Lewis Research Center, Cleveland). pp 477-530 of Strengthening Mechanisms: Metals and Ceramics. Burke, John J.; Reed, Norman L.; Weiss, Volker (eds.). Syracuse, N. Y., Syracuse University Press, 1966.

From 12th Sagamore Army Materials Research Conference, Raquette Lake, N. Y., Aug. 24–27, 1965. See CONF-650846.

The design of composites utilizing the unique or unusual mechanical and physical properties of fibers is reviewed. Composite properties are related to fiber and matrix properties using the law-of-mixtures relation. Deviations from this type of behavior are discussed and related to metallurgical factors that produce them. Concepts generated from evaluation of both the fundamental and developmental work are presented. (J.G.B.)

31031 STUDY OF THE BEHAVIOUR OF FISSION PRODUCTS IN LIQUID SODIUM. Barthoux, A.; Saroul, J. (CEN, Cadarache, France). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-85/9, 24p. (In French). (CONF-661110-14). DTIE.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna.

Out-of-pile experiments were performed to study the behavior of fission products released in Na during the melting of a specimen of irradiated U. With the experimental apparatus employed, it was possible to heat 250 l of Na to a temperature of 550°C and to melt a fuel sample containing about 200 mCi of fresh fission products. Samples were taken from the crucible, the Na, and the cover Ar to determine the various diffusion coefficients for the fuel in the Na and the Na in the Ar. The behavior and the efficiency of various filters were measured with an argon sampling circuit fitted with a coarse filter for the Na vapor, a magnetic filter, various I_2 traps, and a rare-gas trap. With this apparatus it is possible to determine the wall contamination rate and to check the efficiency of various decontamination methods. (auth)

Structure and Phase Studies

Refer also to abstracts 30401, 31005, and 31009.

31032 (AD-643956) COMPUTER INVESTIGATION OF RADIATION DAMAGE IN CRYSTALS. Final Report, June 1965–August 1966. Anderman, Allan (Atomics International, Canoga Park, Calif.). Sept. 1966. Contract AF 19(628)-5120. 100p. (AI-66-252; AFCRL-66-688). CFSTI $3.00 cy, $0.65 mn.

A theoretical study of radiation damage in crystals has been performed, using computer techniques. The materials studied were Cu, Al, and Au. Two major areas of investigation were pursued: (1) the study of various static configurations of lattice defects in Cu and Al, and (2) the study of threshold displacement energies in Au. The major focus of all work done was the effect of the choice of interatomic potential on the calculational results obtained. It is shown that the magnitude of the interstitial defect energies calculated is highly sensitive to the detailed form of the potential employed. With respect to vacancy characteristics, a potential for Cu was developed which leads to excellent agreement with experiment. In addition, a procedure is indicated for modifying this potential to also give meaningful results for interstitial characteristics. Of four Born–Mayer potentials studied for Au, it is shown that only the one derived on the basis of radiation damage data leads to good agreement with experiment for the (100) threshold energy. Threshold studies in the (110) direction indicate highly efficient propagation of energy along the collision line. However, it is concluded that no reasonable judgement concerning the (110) threshold energy can be made from the data obtained. (auth)

31033 (CALT-473-13) DISLOCATION VELOCITY IN COPPER AND ZINC. Vreeland, T. Jr. (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). Apr. 1967. Contract AT(04-3)-473. 29p. (CONF-670513-2). Dep. CFSTI.

From Colloquium on Dislocation Dynamics Conference, Seattle, Wash.

The stress dependence of dislocation velocity in Cu and in the basal and 2nd order pyramidal slip systems of Zn was measured. Dislocations were observed by the etch pit and Berg–Barrett x-ray techniques before and after application of short duration stress pulses. The velocity of dislocations of mixed edge-screw orientation in Cu and of basal edge dislocations in Zn was found to be a linear function of stress at room temperature. This data gives a value of the dislocation damping constant of 7×10^{-4} dyne sec/cm^{-2}, in good agreement with the value deduced from internal friction measurements in Cu. Evidence of an unusual stress and temperature dependence for the velocity of dislocations in slip bands on the 2nd order pyramidal slip system of Zn is reported. (auth)

31034 (N-66-32264) INVESTIGATION OF THE SOLIDIFICATION, STRUCTURE, AND PROPERTIES OF EUTECTIC ALLOYS INCLUDING CONSIDERATION OF PROPERTIES CONTROL. Semi-annual Progress Report No. 2. Hertzberg, R. W.; Kraft, R. W. (Lehigh Univ., Bethlehem, Pa. Inst. of Research). July 14, 1966. 17p. (NASA-CR-76668). CFSTI.

Results of microstructural stability of fibrous Al–$NiAl_3$ eutectics at high temperatures, high temperature Ni–Ni_3Nb eutectic alloys, the mechanical properties of Al–$CuAl_2$ eutectics, the fatigue behavior of Al–Al_3Ni eutectics, and the physical property measurements of Bi–Zn eutectic alloys are reported. (auth)

31035 (RFP-899) TECHNIQUES FOR THINNING PLUTONIUM FOR TRANSMISSION ELECTRON MICROSCOPY. Brewer, Arvel W. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). May 3, 1967. Contract AT(29-1)-1106. 8p. Dep. CFSTI.

Equipment and techniques used to prepare thin films of Pu for electron microscopy are described. Specimens 10 × 18 mm are cut from bulk foil of Pu-1 wt % Ga 0.003 in. thick, clipped to holders, and subjected to the action of a jet of electrolyte circulating through hollow cathodes and impinging simultaneously on both sides of the specimens. The method reduces preferential attack which occurs during ordinary electropolishing. Operations are conducted in an A type satellite glove box. (P.G.C.)

31036 (UCRL-17330, pp 79-121) METALLURGY. (California Univ., Berkeley. Lawrence Radiation Lab.).

Developments are reported for studies on: crystal imperfections; kinetics of dislocation mechanisms; relation of structure to properties in metallic systems; high-strength materials; high-field superconductivity; and thermodynamics of metal systems. (P.C.H.)

31037 (AD-637378) INVESTIGATION OF STEELS AND ALLOYS (SELECTED ARTICLES). Translated from Issled. Stalei Splavov, Akad. Nauk SSSR, Gos. Kom. Chern. Tsvetn. Met. Gosplane, SSSR, Inst. Met., 121-4; 147-9(1965). 16p. (FTD-MT-65-412). CFSTI. JCL $1.60 fs, $0.80 mf.

Two translated papers are presented. A separate abstract was prepared for one. The other was previously abstracted for NSA and appeared as abstract 19: 20604. (M.C.G.)

For an abstracts of the individual paper see: 31038.

31038 (AD-637378, pp 9-13) INFLUENCE OF TITANIUM AND MOLYBDENUM ON THE TEMPERATURE OF RECRYSTALLIZATION AND HARDENING OF NIOBIUM ALLOYS. Kontorovich, I. E.; Savkina, L. Ya. Translated from Issled. Stalei Splavov, Akad. Nauk SSSR, Gos. Kom. Chern. Tsvetn. Met. Gosplane, SSSR, Inst. Met., 147-9(1965).

Alloying of niobium with titanium in quantities of 2 to 10% lowered the recrystallization temperature of the alloys and did not cause hardening. On alloying of niobium with molybdenum (from 2 to 10%) the recrystallization temperature increased and essential hardening of the alloys in the cold and heated state was attained. (auth)

31039 (SC-T-67-0916) DISLOCATIONS IN BERYLLIUM TWINNING AND DEFORMATION BY CLIMB. Poirier, J. P.; Antolin, J.; Dupouy, J. M. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from J. Phys. (Paris), Colloq. 27: Suppl. to Nos. 7-8, C3-98-102(July-Aug. 1966). 12p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Single crystals of Be, compressed along the c axis, above 400°C, undergo a deformation that can be ascribed to the climb of $\bar{c}$ dislocation loops possibly created by Bardeen-Herring sources. Observations of twins gave evidence supporting the theory of twinning by dislocations. Numerous stacking faults were also found in twins; they result from the condensation of vacancies created during twinning. (auth)

31040 KINETICS OF THE OXIDATION OF TUNGSTEN BY CO_2 AT HIGH TEMPERATURES. Walsh, Patrick N.; Quets, Jean M.; Graff, Robert A.; Ladd, Irwin R. (Union Carbide Research Inst., Tarrytown, N. Y.). J. Chem. Phys., 46: 3571-6 (May 1, 1967).

The kinetics of oxidation of W by CO_2 was studied in a stagnation-flow reactor at CO_2 partial pressures from 20 to 337 torr. The study covered the temperature range 2200°-3200°K and included measurements of the effect of CO on the reaction kinetics at CO/CO_2 ratios up to 5:1. The rates observed below about 2650°K were essentially independent of the velocity of the impinging gas stream indicating that the surface kinetics primarily determined the rates up to 2650°K at the lower gas-flow rates used and to higher temperatures at higher flow rates. Where surface kinetics were rate determining, the data could be explained simply by incorporating a temperature-dependent "sticking coefficient" for CO_2 into the two-layer adatom model previously proposed for the $W-O_2$ reaction. The effect of CO was small and was readily incorporated into the model. Velocity-dependent deviations from the rates predicted by the model were observed at temperatures above 2650°K. These were largely explained by simple mass-transfer theory. At low flow rates and high temperatures it appears that the reactions of desorbed O_2 became important. (auth)

31041 FINE FAULTS AND CRYSTAL STRUCTURES OF PRECIPITATES IN Fe-Mo AND Fe-W ALLOYS. Yagisawa, Kohei; Fujita, Hiroshi (National Research Inst. for Metals, Tokyo). Jap. J. Appl. Phys., 6: 826-39(July 1967).

To investigate crystal structure and two-dimensional faults of the precipitates in Fe-Mo alloys, an electron-microscopic method was used. The crystal structure of the precipitates in Fe-Mo alloys aged above 1000°C was rhombohedral, while it was generally hexagonal in the alloys aged below 900°C. Both precipitates were formed in approximately the same amount when aged at 940°C. Numerous two-dimensional faults were on $\{00.1\}_{hex}$, $\{10.1\}_{hex}$ and $\{10.0\}_{hex}$ planes in the precipitates of hexagonal structure and on $\{111\}_{rhomb}$ and $\{100\}_{rhomb}$ planes in the precipitates of rhombohedral structure. In the hexagonal precipitates in the Fe-W alloy aged at 950°C, faults were observed also on $\{00.1\}_{hex}$ and $\{10.1\}_{hex}$ planes. (auth)

31042 EFFECT OF ANNEALING ON THE STRUCTURE AND SUBSTRUCTURE OF DEFORMED MOLYBDENUM ALLOYS. Bernshtein, M. L.; Lyuttsau, V. G.; Demina, E. L.; Chursina, G. N. (Moscow Inst. of Steel and Alloys). Fiz. Metal. Metalloved., 23: 340-2(Feb. 1967). (In Russian).

Previous studies revealed that the deformation resistance of Mo-Ti alloys increases with increased annealing time. This study is concerned with the effect of temperature and duration of annealing on structural changes taking place in deformed Mo alloys. It was found that at 1200°C, there is some increase in the size of grains with increasing annealing time in Mo specimens previously deformed with 9% reduction. Radiographic study of the grain substructure revealed that the disorientation angle of the grains in deformed Mo-Ti alloys decreased with increasing annealing time. Also, the size of individual subgrains was longer in cold deformed and annealed specimens than in those deformed at 1150°C and annealed. This indicates that deformation at high temperatures facilitates the formation of a more solid substructure during subsequent annealing. In Mo-Zr alloys, the grain disorientation angle decreased up to 100 hr but remained constant from then on, due to the increased size of subgrains. The test results proved that strengthening of Mo alloys depends on the post-deformation annealing which affects the substructural changes. (ATD)

31043 SINGLE CRYSTALS OF THE COMPOUNDS HfCuSi AND $ThCu_2Si_2$. Nickl, J.; Sprenger, H. (Univ., Munich). Naturwissenschaften, 54: 248(1967). (In German).

In the systems Hf-Cu-Si the compound HfCuSi was found at high Cu concentrations. The compound can be isolated as plate-like single crystals. It was assigned an orthorhombic unit cell with the space group $D^{16}2h$ = Phnm. The stoichiometric ratio Hf:Cu:Si = 1:1:1 was found by chemical analysis. In the Th-Cu-Si system no similar phase could be found. The isolated single crystal was identified chemically and by x-ray diagrams as $ThCu_2Si_2$. (tr-auth)

31044 ISOTHERMAL SECTIONS AT 600 AND 750°C OF THE MOLYBDENUM-TITANIUM-ZIRCONIUM PHASE DIAGRAM. Prokoshkin, D. A.; Zakharova, M. I. (Inst. of Metallurgy, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 87-93(Jan. 1967). (In Russian).

On the basis of x-ray and microstructural analyses and measurements of the hardness of alloys after quenching from the equilibrium state at 750 and 600°C, isothermal sections at these two temperatures of the phase diagram of the Mo-Ti-Zr system were constructed. A sizable region of a β solid solution, extending continuously from the Mo-Ti system to the Ti-Zr system and bounded by a region of heterogeneous state of the alloys on the side of the Mo-Zr system, was found in the section at 600°C. The region of heterogeneous state of the alloys occupies a small part of the concentration triangle and protrudes toward the Ti corner. Unmixing of the β solid solution into two solid solutions occurs at an equiatomic content of Mo in Zr and 61 at. % Ti. Two three-phase regions, $\beta_1 + \beta_2 + \delta$ and $\alpha + \beta_2 + \delta$, exist inside the heterogeneous region. The δ phase extends up to 13 at.% Ti at 33.3 at.% Zr in the ternary system; no appreciable solubility was noted in this phase. The isothermal section at 750°C is basically no different from the section at 600°C, but the region of the β solid solution increases considerably, both at the expense of the heterogeneous region (on the side of the Mo-Zr system) and at the expense of the two-phase $\alpha + \beta$ regions adjacent to the Ti and Zr corners of the section. Unmixing of the β solid solution takes place at 57 at.% Ti and 19 at.% Zr. At 750°C, the region of the δ phase degenerates into a line (as it does at 600°C) and exists in this section up to 15 at.% at 33.3 at.% Zr. (ATD)

31045 YTTRIUM-LEAD ALLOY SYSTEM. Carlson, O. N.; Schmidt, F. A.; Diesburg, D. E. (Ames Lab., Iowa). Amer. Soc. Metals, Trans. Quart., 60: 119-24(June 1967). (IS-1457).

The Y-Pb alloy system was investigated by thermal analysis, microscopic, and x-ray methods. An inverse peritectic reaction occurs on the Y-rich end of the system and there is a eutectic at 14 at.% Pb and 1240°C between Y and the compound, Y_5Pb_3, which melts congruently at 1760°C. The Pb-rich side of the system consists of a series of peritectic reactions associated with three additional compounds. From x-ray diffraction data and microscopic evidence, the compositions of these compounds were determined to be Y_5Pb_4, YPb_2, and YPb_3. Horizontals corresponding to the decomposition temperatures of these compounds occur at 1650, 945, and 740°C, respectively. (auth)

31046 TRANSFORMATION IN A SOLID STATE IN CHROMIUM ALLOYS WITH VANADIUM AND MOLYBDENUM IN CHROMIUM RICH REGION. Bezus, E. V.; Sokolovskaya, E. M.; Grigor'ev, A. T.; Galkina, L. V. Vestn. Moskov. Univ., Ser. II, Khim., No. 6, 38-42(Nov.-Dec. 1966). (In Russian).

Although the three binaries of the Cr-Mo-V system are known to contain continuous solid solutions, transformations of pure Cr cause the appearance of two-phase areas in the Cr-rich region of

the Cr–Mo system; similar two-phase areas of the Cr–V binary were attributed to the presence of impurities. In order to clarify the nature of these two-phase areas, the Cr–V binary and the Cr–V–Mo ternary systems were investigated in the Cr-rich region by microscopy, thermal analysis, and x-ray diffraction methods; the high-temperature hardness, the microhardness, and electric resistivity of the alloys were also determined. The four 2-phase areas, $\alpha + \beta$; $\beta + \gamma$; $\gamma + \delta$; and $\delta + \epsilon$, agreed with the known transformations of Cr. The one- and two-phase areas were found to alternate, as the V content of the alloys was increased; the boundary of the two-phase region was defined by the breaks in the electric resistivity–temperature and hardness–composition curves of the alloys. Similar studies on the ternary system, with the Mo:V ratio kept at 1:1, revealed the presence of the same two-phase regions. The two-phase region boundaries at various temperatures were found to depend on the quenching temperature, as in the binary system; they were also determined by the breaks in the hardness curves. (TTT)

31047 PHASE RELATIONS IN THE ZINC-RICH PORTION OF THE PLUTONIUM–ZINC SYSTEM. Cramer, E. M.; Wood, D. H. (Univ. of California, Livermore). J. Less-Common Metals, 13: 112-21 (July 1967). (UCRL-70208).

Thermal analysis, metallography, and single-crystal x-ray-diffraction were used to study seventeen compositions up to 22 at. % Pu in Zn. Several variations with the existing literature were found. A previously unknown compound at roughly 11.5 at. % Pu was characterized as body-centered tetragonal, a = 8.8 Å, c = 21.2 Å. Pu_2Zn_{17} of the Th_2Zn_{17}-type was found to be congruent melting. These two phases and three others observed to have hexagonal symmetry are all considered as superlattices based on the $CaZn_5$ structure type. One of the hexagonal phases is of the "Th_2Ni_{17}-type." Twinning and Widmanstatten-type precipitation were observed in Pu_2Zn_9. A proposed phase diagram and photomicrographs are presented. (auth)

31048 PLASTIC DEFORMATION OF TANTALUM SINGLE CRYSTALS. I. THE SURFACE MORPHOLOGY OF YIELD. Byron, J. F.; Hull, D. (Univ. of Liverpool). J. Less-Common Metals, 13: 71-84 (July 1967).

The changes in surface morphology of Ta single crystals during deformation are described as a function of orientation at 273 and 77°K in tension, and at 293 and 77°K in compression. The operating slip planes have been analyzed using Taylor's method. In tension at 273 and 77°K the operating slip planes were associated with the planes of maximum resolved shear stress. Deviations of the observed slip plane from the plane of maximum shear stress were generally towards the nearest {110} and were greater at 77°K. In compression, the deviations of the observed slip planes from the planes of maximum resolved shear stress were greater than in tension but were towards {110}, and were greater at 77°K. For both tension and compression, the deviations of the observed slip plane from the plane of maximum shear stress were found to be orientation dependent. The results are interpreted in terms of asymmetry of slip on {112} planes. (auth)

31049 STUDIES OF PSEUDO-BINARY LAVES-PHASE SYSTEMS CONTAINING LANTHANIDES. I. CONSTITUTION AND MAGNETIC PROPERTIES OF THE $GdAl_2$–$GdFe_2$, $GdAl_2$–$GdCo_2$, AND $ErCo_2$–$ErAl_2$ SYSTEMS. Oesterreicher, H.; Wallace, W. E. (Univ. of Pittsburgh). J. Less-Common Metals, 13: 91-102 (July 1967).

Crystallographic and magnetic characteristics (susceptibilities and saturation magnetization at 4.2°K) are presented for the pseudo-binary systems $GdAl_2$–$GdFe_2$, $GdAl_2$–$GdCo_2$ and $ErAl_2$–$ErCo_2$. A C14 structure is observed at compositions GdFeAl, GdCoAl and ErCoAl. The composition range over which this structure and the two C15 terminal phases exist was determined. The structure change produced when Co or Fe is replaced by Al is ascribed to Brillouin Zone filling effects such as have been observed with the prototype Laves phases. The phase boundary for the terminal phase based on $GdFe_2$, $GdCo_2$ or $ErCo_2$ corresponds to near filling of the second Brillouin Zone for the C15 structure, i.e., contact of the Fermi Surface with the 220 faces. The evidence supports the concept of electron transfer from Gd, Er or Al to Fe or Co. The transfer occurs to the extent that Fe and Co are apparently non-magnetic in alloys containing more than 36 and 90 mole % $GdAl_2$ in $GdCo_2$ and $GdFe_2$, respectively. (auth)

31050 PHASE RELATIONS AND INTERMETALLIC COMPOUNDS IN THE LANTHANUM–COBALT SYSTEM. Buschow, K. H. J.; Velge, W. A. J. J. (Philips' Research Labs., Eindhoven, Netherlands). J. Less-Common Metals, 13: 11-17 (July 1967).

The La–Co system has been studied over the whole range of composition. The following intermetallic compounds were observed: La_3Co, La_xCo, La_2Co_3, α-La_2Co_7, β-La_2Co_7, $LaCo_5$ and $LaCo_{13}$. The lattice parameters for these compounds have been determined and in addition, for La_3Co, α-La_2Co_7, β-La_2Co_7, $LaCo_5$, and $LaCo_{13}$ the structure type is given. From the x-ray data together with the results of thermoanalytical and metallographic examinations a tentative phase diagram has been constructed. The results obtained for the La–Co system are compared with those obtained for other rare-earth Co systems. (auth)

31051 LATTICE SPACINGS AND EFFECTIVE ATOMIC DIAMETERS IN THE TERNARY SYSTEMS FORMED BY Th AND Ce WITH Y, La, Gd, AND Er, AND BY Th, Pr, AND Y. Norman, M.; Harris, I. R.; Raynor, G. V. (Univ. of Birmingham, Eng.). J. Less-Common Metals, 13: 24-44 (July 1967).

Analysis of lattice spacing relationships in the Th-rich solid solutions in the systems Th–Y–Ce, Th–La–Ce, Th–Gd–Ce and Th–Er–Ce shows that the electronic constitution, and the apparent atomic diameter, of Ce in solid solution is strongly influenced by environment. The Th in Th–20 at. % Ce alloys is replaced by 3-valent metals to form the ternary alloy, and the contraction of the Ce atoms is decreased in the cases studied. In the systems Th–Gd–Ce and Th–Er–Ce the contraction decreases in spite of the fact that the mean lattice spacing of the composite Th–Gd or Th–Er solvent decreases with increasing Gd or Er content. This contrasts with the case of Th–Zr–Ce alloys, where the mean lattice spacing of the composite solvent decreases as Zr replaces Th, and the contraction of Ce atoms in solid solution is enhanced. The results are discussed in terms of the effects on Ce atoms in solid solution of (i) the strain energy of alloying, and (ii) the effective valency and electronic constitution of the matrix in which the Ce is dissolved. Further interest attaches to the Th–Gd–Ce alloys, in which the apparent atomic dia of Gd is also found to be variable. This is discussed in terms of the modification of magnetic interactions between the Gd atoms. (auth)

Radiation Effects

Refer also to abstract 30978.

31052 (ANL-7185) NEUTRON IRRADIATION OF PURE METALS AND ALUMINUM–ZINC ALLOYS. Horak, James A. (Argonne National Lab., Ill.). Oct. 1966. Contract W-31-109-eng-38. 83p. Dep. CFSTI.

To determine the source of the initial electric conductivity rise during neutron irradiation of metals near 4°K and the induced resistivity produced by a fission-neutron spectrum, the metals Al, Cu, Ag, Au, Pt, Pd, Fe, and Ni were irradiated at about 4.5°K in the Argonne CP-5 VT-53 cryogenic facility. The initial resistivity increase that occurs in low-temperature neutron irradiation of metals is thermal in nature and appears to be due to gamma-ray heating. The irradiation-induced resistivity, ρ_i, as a function of time, t, at about 4.5°K, obeys the equation $\rho_i = A(1 - e^{-\alpha t}) + B(1 - e^{-\beta t})$, where A, B, α, and β are experimentally determined parameters for each metal. The first term is attributed to the production of displacement cascades, and the second to stable defect clusters or dislocation loops produced by the interaction of the cascades. The irradiation effects in this facility are due to fission neutrons, the damage rate being 13 times that of the ORNL Hole 12 facility and one-fifth that of the Munich FRM facility. In addition, Al and the alloys Al-1.70, Al-3.41, and 5.27 a.% Zn in the quenched state and in the reverted state have been irradiated and isochronally annealed to study the effects of irradiation-induced lattice defects on the formation of Guinier–Preston (G.P.) zones. The damage rate for the Al and the alloys was the same, indicating that no G.P. zones formed during irradiation. The defects that are mobile below 77°K do not appear to affect G.P. zone formation in these alloys. The formation of G.P. zones began at the same temperature as the start of Stage III in Al, suggesting that the same defect, the vacancy, is responsible for both processes. Recovery was complete in Al at 260°K, but continued up to 400°K in the alloys. This indicates that there is an interaction between vacancies and Zn atoms that gives the vacancies a much longer lifetime in the alloy than in the Al. Irradiation greatly enhanced zone formation, especially in the reverted case, and the temperature of the start of zone formation and of the resistivity maximum was a function of defect concentration. These results suggest that the formation and growth of the G.P. zones in Al–Zn alloys are controlled by the point-defect concentration. (auth)

31053 (BMwF-FBK-67-27) REAKTORNEUTRONEN-BESTRAHLUNG VON HALBLEITER-EINKRISTALLEN BEI TIEFEN TEMPERATUREN UND DEREN AUSWIRKUNG AUF HALL-EFFEKT UND ELEKTRISCHE LEITFAEHIGKEIT. (Reactor–Neutron Irradiation of Semiconductor Single Crystals at Low Temperatures and Its Influence on Hall-Effect and Electrical Resistivity). Wolf, D. (Kiel Univ. (West Germany). Institut fuer Reine und Angewandte Kernphysik). Apr. 1967. 14p. (In German). Dep.

Experiments are reported on Ge single crystals, irradiated at 77°K with fast reactor neutrons up to doses of 8×10^{12} nvt. Subsequent to irradiations isochronal and isothermal annealing curves have been recorded. Preparations to extend these experiments to higher neutron doses and to lower temperatures are described. (auth)

31054 (BNWL-CC-1053) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS. Quarterly Progress Report, November, December 1966–January 1967. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 15, 1967. Contract AT(45-1)-1830. 203p. Dep. CFSTI.

Research progress is reported on: fast-neutron spectra and radiation damage rates, radiation effects on reactor structural materials, in-reactor testing of steels, effects of radiation on refractory metals and heat-resisting alloys, tensile tests, radiation metallurgy, radiation damage to metals, fission track dosimetry, irradiation facilities, and corrosion of superalloys and refractory metals. (M.C.G.)

31055 (BNWL-SA-377) APPLICATIONS OF FRACTURE MECHANICS IN EVALUATING THE INITIATION AND PROPAGATION OF BRITTLE FRACTURE IN REACTOR STRUCTURAL COMPONENTS. Hoagland, R. G.; Bement, A. L.; Rowe, R. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 30, 1966. Contract AT(45-1)-1830. 30p. (CONF-660607-7). Dep. CFSTI.

From 3rd International Symposium on the Effects of Irradiation on Structural Metals, Atlantic City.

Fracture mechanics studies are being conducted to determine the effects of reactor environments and fabrication variables on the fracture characteristics of materials. Testing procedures were developed for measuring the plane strain stress intensity for both crack initiation and arrest over a wide temperature range. Special techniques are described for evaluating the fracture toughness profile across the fusion and heat affected zone in post-weld heat treated A302-B, the effects of neutron irradiation on the fracture toughness of Zircaloy-2, and the sub-critical crack growth in a high strength steel. Data from these studies are presented and the various applications of the data to reactor components through the use of fracture mechanics is discussed. (auth)

31056 (EUR-3257.e) EMF DEVIATION OF CHROMEL/ALUMEL THERMOCOUPLES CAUSED BY NEUTRON IRRADIATION. IRRADIATION EXPERIMENT TIC-01. Gottschlich, R.; Bellezza, M. (European Atomic Energy Community, Petten (Netherlands). Joint Nuclear Research Center). Dec. 1966. 32p. Dep.

Studies were made on the nuclear stability of Chromel/Alumel thermocouples by measuring the emf deviation caused by neutron irradiation. Experience was also obtained in handling and remote welding of radioactive wires. The capsule containing bare wires for 20 thermocouples was irradiated in HFR position F-2 for two reactor cycles, corresponding to average neutron fluxes of 4.5×10^{20} cm^{-2} thermal and 1.4×10^{20} cm^{-2} fast. Two calibration methods were used. The first method consisted of calibration of remote-welded thermocouples, each of them consisting of one irradiated and one non-irradiated wire of the same composition. The second method was emf comparison of thermocouple pairs welded from irradiated wires, with non-irradiated thermocouples made from wires of the same origin. The results showed a negative emf drift of irradiated thermocouples of 0.8% (average value). The remote welding procedure is appended. (P.C.H.)

31057 (EURAEC-1472) EFFECT OF NITROGEN ON THE MECHANICAL PROPERTIES OF NEUTRON IRRADIATED PURE IRON. Castagna, M.; Rossi, F. S.; Ferro, A.; Sebille, J. (Societa Ricerche Impianti Nucleari, Saluggia (Italy). Centro Ricerche Nucleari). 1966. Contract 004-63-10-TEEI. 32p. (EUR-2393.e; CONF-660607-10). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

From 3rd International Symposium on the Effects of Irradiation on Structural Metals, Atlantic City.

An investigation was made of the role of interstitials, and more particularly of N, on the changes of mechanical properties of iron after fast-neutron irradiation and after annealing. The changes in mechanical properties of pure Armco iron remelted in vacuo and with the last traces of interstitials completely blocked by suitable titanium addition were determined on specimens of different grain sizes. This material showed a value of k_y in the Petch equation extremely low: the value of δ_0 in the Petch equation increased linearly with Ti concentration. After irradiation up to 1.4×10^{19} nvt (>1 MeV) at a temperature below 55°C, this material showed somewhat anomalous Petch lines, with higher values of k_y in the coarse-grain range and a low value in the fine-grain-size region. The transition temperature for resilience (subsize V-notch specimens) increased after irradiation from about −60 to about +10°C. Armco iron remelted in vacuo and deoxidized with Si or Al, in which a rather large concentration of N_2 (0.02 weight %) was introduced had a value of k_y strongly reduced by irradiation. No anomalous behavior in the Petch was observed. The transition temperature increased from about +20 to about +180°C for Si-killed specimens, while it increased only from about −50 to about +17°C, i.e. about the same as for interstitial-free material, for Al killed specimens. (auth)

31058 (EURAEC-1857) A NEW DETERMINATION OF THE EMBRITTLEMENT IN STEEL USING SMALL SPECIMENS (~0.2 cc) IN PARTICULAR WITH RESPECT TO IRRADIATION. Progress Report M67-403-50005, January 1, 1967-March 31, 1967. van Elst, H. C. (Metaalinstituut TNO, Delft (Netherlands)). Apr. 28, 1967. Contract 060-64-11-TEEN. 72p. (EUR-3362). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

Specimens of neutron irradiated Al grain-refined reactor vessel steel were tested by stress wave attenuation to determine the embrittlement of the steel by irradiation. The results were compared with Charpy-V and Robertson test results on similarly irradiated steel carried out by U.K.A.E.A. A smaller increase in the arrest temperature was deduced from the stress wave attenuation test than actually found by the Robertson test performance at U.K. A.E.A. An investigation of the influence of increased lateral dimensions of the specimens on the recordings in the stress wave attenuation test and on the evaluation of the relative energy absorption from these, was carried out on low-C construction steel at room temperature. (auth)

31059 (HW-84517) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS. Quarterly Progress Report, August–October 1964. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Nov. 16, 1964. Contract AT(45-1)-1350. 247p. Dep. CFSTI.

Research progress is reported on: radiation effects on bcc metals, neutron effects on materials subjected to multiaxial stress distributions, reactor metals, chemical metallurgy, gas loop development, physical metallurgy, effects of radiation on high-temperature metals and alloys, and radiation testing of reactor structural materials. (M.C.G.)

31060 (IN-1105) PROGRESS REPORT ON THE ^{232}Th–^{233}U IRRADIATION PROGRAM AT THE MATERIALS TESTING REACTOR. Nisle, Robert G.; Aber, Eugene F. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). June 1966. Contract AT(10-1)-205. 18p. Dep. CFSTI.

Four Th–U samples as follows were irradiated in the MTR for three cycles: one containing 61.58 grams ^{232}Th; one containing 64.47 grams ^{232}Th and 0.6487 grams ^{233}U; one containing 63.75 grams ^{232}Th and 0.8200 grams ^{233}U; and one containing 62.255 grams ^{232}Th and 1.0016 grams ^{233}U. Reactivity measurements were made at two times about two weeks apart between irradiation periods. The reactivities were extrapolated to t = 0, the time the samples were removed from the irradiating flux, and to t = ∞, i.e., at long decay times compared to the ^{233}Pa half-life. Such calculated reactivities are a rough indication of the ^{233}U and ^{233}Pa content of the samples. The results indicate that the ^{233}U content changed least in the sample that originally contained 1.3% ^{233}U. These samples are presently scheduled for ten cycles of irradiation. However, it is recommended that this sequence of irradiations be terminated at the end of five cycles. Present plans are to start a new sequence of irradiations in a substantially harder flux with four fresh samples. (auth)

31061 (ORNL-P-3117) ELECTRON MICROSCOPE OBSERVATIONS ON THE DISLOCATION ARRANGEMENT IN COPPER SINGLE CRYSTALS IN THE STRESSED CONDITION. Crump III, J. C.; Young, F. W. Jr. (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 5p. (CONF-670513-3). Dep. CFSTI.

From Colloquium on Dislocation Dynamics Conference, Seattle, Wash.

Three Cu single crystals were spring loaded under compression and irradiated at ambient temperature with 2×10^{17} fast neutrons with the stress applied to pin dislocations in their as-stressed position. The crystals were compressed to 500, 100, and 40 g/mm^2. The dislocation configurations in the crystal compressed to 500 g/mm^2 were identical to those observed in Cu samples similarly stressed and then relaxed. Some of the dislocation bundles tended to be aligned along the traces of the conjugate and critical planes. They were composed of primary edge dislocation dipoles and some secondary edge dislocations. For the crystal compressed to 100 g/mm^2 the dislocation arrangements were very different. A number of long dislocations, some in the screw orientation and

others in mixed orientation, were observed. Long dislocations, most in a mixed orientation, which lie on the primary slip planes and intersect to form networks, were observed in the crystal compressed to 40 g/mm^2. (M.C.G.)

31062 EFFECT OF GAMMA RADIATION ON THE ELECTRIC RESISTANCE OF FILMS OBTAINED BY EVAPORATION OF SILVER, ALUMINUM, NICKEL, AND PERMALLOY. Belous, M. V.; Permyakov, V. G.; Popov, V. I.; Bassina, I. F. (Kiev Polytechnical Inst.). Fiz. Metal. Metalloved., 23: 376-7(Feb. 1967). (In Russian).

The effect of 10^7, 10^8, 10^9 rad on the electrical properties of vacuum metal condensates in sealed ampoules was investigated. Irradiation of Ag and Al condensates in air with a dose of 10^7 rad causes an irreversible increase in film electrical resistance (10 to 20%). Radiation up to 10^8 to 10^9 rad causes a further increase in electrical resistance, whereupon the Ag condensate reaches unmeasurable values. The irradiation of Al condensates at 10^9 rad causes a 50 to 100% increase in electrical resistance. Irradiation of Ni and permalloy condensate in air with a dose of 10^7 rad caused an irreversible decrease in electrical resistance of approximately 20%. A similar effect was observed by heat treatment of condensates in vacuum. However, an increase in radiation dose up to 10^8 to 10^9 rad was accompanied by an unlimited increase in electrical resistance. Evaporation of Al, Ag, Ni, and permalloy in vacuum considerably reduced the effect of gamma radiation on electrical resistance. One of the possible reasons for an increase in film electrical resistance is the interactions of the condensate with atmospheric gases; gamma radiation intensifies this interaction. With an increase in Ni film thickness, the rate of increase in electrical resistance decreased. An increase in radiation dose causes an increase in the rate of electrical resistance. Similar behavior occurs in permalloy. The Al condensates are less affected by gamma rays and the Ag are most affected. (D.L.C.)

31063 EFFECT OF NEUTRON IRRADIATION ON CERTAIN PROPERTIES OF TUNGSTEN. Ibragimov, Sh. Sh. Fiz. Metal. Metalloved., 23: 354-7(Feb. 1967). (In Russian).

Specimens of technical-purity W were placed in special stainless-steel ampoules and irradiated with doses of from 0.7×10^{19} to 2.4×10^{20} neutrons/cm^2 ($E \geq 1$ MeV) in the reactors BR-2 and BR-5. Their electrical resistance ρ was determined with the aid of a KL-48DU potentiometric setup, and their hardness H_V, with the aid of a Vickers-type device. It was established that neutron irradiation at 40 to 360°C results in an increase in ρ and H_V of W in direct proportion to the integral radiation dose, particularly for ρ, since an appreciable increase in H_V occurs only in the presence of high radiation doses. At −196 to 50°C, the increase in the ρ of the irradiated W markedly slows down; this is apparently associated with the decrease in the characteristic (Debye) temperature of the irradiated metal. This is due to the formation of radiation-induced defects such as interstitial atoms and vacancies. As regards the effect of annealing, it is found that the decrease in ρ of irradiated W as a function of annealing temperature occurs in at least three stages, whereas the decrease in hardness occurs within a narrow range of high annealing temperatures. The decrease in the ρ of W irradiated at 220 to 250°C clearly displays two regions of sharp decline: the low-temperature region (annealing temperatures 320 to 475°C) and the high-temperature region (annealing temperatures 800 to 900°C); clearly, each region of the curve is conditioned by the annealing of a different type of defects. The observed sharp decrease in ρ at 320 to 475°C is due to the annealing-caused elimination of interstitial atoms, while the final sharp decrease in ρ occurring in the high-temperature state of annealing (800 to 900°C) is due to the annealing-caused elimination of unitary vacancies. As for the increase in H_V, i.e. the radiation hardening of W, this is associated with defects of a more complex type, which get completely eliminated only at an annealing temperature of ~1350°C. (ATD)

31064 CERTAIN ASPECTS OF THE CHANGES IN THE MICROHARDNESS OF NEUTRON-IRRADIATED CHROMIUM DURING ITS ANNEALING AND DEFORMATION. Kritskaya, V. K.; Kuznetsova, A. P.; Sharov, B. V.; Spasskii, M. N. (Inst. of Metal Science and Physics of Metals, Moscow. Inst. of Theoretical and Experimental Physics, Moscow). Fiz. Metal. Metalloved., 23: 289-92(Feb. 1967). (In Russian).

An investigation was made of the changes in mechanical properties of irradiated specimens of Cr with different dislocation densities and states of impurity atoms in the lattice. Following their irradiation with a dose of 10^{20} neutrons/cm^{-2} in a reactor at ~80°C, all three types of specimens were annealed at 0 to 1000°C and cold-deformed from 0 to 100%. The experiments were performed with specimens of electrolytic Cr, some of which were quenched from 950°C and annealed at 920°C prior to irradiation. The phenomenon of "radiation aging" was discovered in Cr; the effect of this aging decreases following cold plastic deformation in inverse proportion to the degree of this deformation. In the non-irradiated specimen, on the other hand, the effect of deformation aging increases with increase in degree of deformation. Hot plastic deformation prior to irradiation, followed by high-temperature annealing, completely eliminates the ageability of irradiated Cr. Irradiated Cr subjected to a high degree of cold plastic deformation (~80% reduction of area) displays virtually no increase in hardness, whereas non-irradiated specimens subjected to the same degree of deformation become markedly hardened. As the degree of deformation is increased above 80%, the microhardness of both irradiated and non-irradiated specimens sharply increases and becomes virtually identical. A similar pattern of variation in microhardness has also been observed for the cold plastic deformation of irradiated and non-irradiated specimens. The fact that, in a number of cases, neutron-irradiated metals display no hardening at relatively high degrees of cold plastic deformation may apparently be attributed to the deformation-induced reduction in the number of the radiation defects impeding the movement of dislocations. (ATD)

31065 ENERGY DISTRIBUTION OF SHOCKS CREATED BY PARTICLES DISPLACED BY IRRADIATION INSIDE AN ALLOY. Joyes, Pierre (CNRS, Paris. Univ., Paris, Orsay, France). Compt. Rend., Ser. A and B, 264: 1204-7(Apr. 17, 1967). (In French).

The application of calculation methods using the Laplace transformation makes it possible to evaluate simply the energy distribution of particles displaced by irradiation inside an alloy. The alloy is compared to an infinite medium and the collisions are described by a hard sphere model. (tr-auth)

31066 DISCUSSION: THE IRRADIATION EFFECTS IN URANIUM ALLOYS AND COMPOUNDS. Lobb, R. C.; Buckley, S. N.; Pollard, G. J. Inst. Metals, 95: 28-32(Jan. 1967).

Three sessions were held in which various contributors reported results of their experimental work on radiation growth and creep in U and its alloys, radioinduced swelling in U and its alloys, and radiation effects in U compounds. (UK)

31067 URANIUM ALLOYS CONTAINING SMALL AMOUNTS OF ALLOYING ELEMENTS. Aubert, H. (to Commissariat a l'Energie Atomique). Canadian Patent 755,016. Mar. 21, 1967. Priority date Aug. 7, 1963, France.

U alloys having a fine grain structure (average 0.3 mm) in the alpha phase can be economically prepared by melting and casting in vacuo. The composition is: Mo 0.10 to 0.30%, Cr 0.05 to 0.20%, and Fe 0.01 to 0.05%; the remainder is U. Such alloys have good mechanical properties such as low creep rates, tensile strength nearly three times that of unalloyed U and good resistance to deformation under irradiation. (F.S.A.)

Ceramics and Cermets

31068 ACTIVATION ENERGIES FOR HYDROGEN DIFFUSION IN THORIUM HYDRIDES. Will, J. D.; Barnes, R. G. (Iowa State Univ., Ames). J. Less-Common Metals, 13: 131-2 (July 1967). (IS-1533).

Results of measurements in several composition ranges of the Th−H system are presented. Activation energies deduced from the measurements are summarized tabularly and include the spin lattice or longitudinal time. (J.R.D.)

Preparation and Fabrication

Refer also to abstract 31105.

31069 (AERE-M-806) PREPARATION OF MAGNESIUM OXIDE CERAMICS CONTAINING LUTETIUM AND MANGANESE. Wheatley, C. C. H. (Atomic Energy Research Establishment, Harwell (England)). Jan. 1961. 7p. Dep. CFSTI.

A method of preparation of small discs of a dilute dispersion of Mn and Lu in a MgO ceramic is described. (auth)

31070 (BNWL-416) CHEMICAL THINNING OF PNEUMATICALLY IMPACTED UO_2 FOR ELECTRON TRANSMISSION MICROSCOPY. Bauleke, M. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1967. Contract AT(45-1)-1830. 11p. Dep. CFSTI.

Procedures for chemical thinning of $UO_{2\pm x}$ and resulting electron micrographs of thinned areas are described. Polycrystalline pneumatically impacted $UO_{2\pm x}$ specimens having O:U ratio ranging between 1.90 and 2.15 were chemically thinned to 100 kV electron transparency. Hypostoichiometric UO_{2-x} was easier to thin than hyperstoichiometric UO_{2+x}; stacking fault dislocations were easily seen in UO_{2-x}, but seldom seen in UO_{2+x}. (P.C.H.)

31071 (LA-3677) FLAME SPRAYING URANIUM OXIDE. Rosenthal, J. J.; Tinkle, M. C. (Los Alamos Scientific Lab., N. Mex.). Feb. 1967. Contract W-7405-eng-36. 7p. Dep. CFSTI.

Using specially prepared UO_2 powders, a technique was developed for depositing depleted and enriched UO_2 coatings by flame spraying with an oxyacetylene powder-feed type gun. The coatings were adherent to stainless steel substrates. Chemically, the as-sprayed coatings were little changed from the starting material. (auth)

31072 (UCRL-Trans-1345) INVESTIGATION OF THE SINTERING OF MULLITE REFRACTORIES SYNTHESIZED FROM TECHNICALLY PURE MATERIALS. Kroll', E. B.; Poluboiarinov, D. N. Translated for Univ. of California Lawrence Radiation Lab., Berkeley, from Tr., Gos. Nauch.-Issled. Inst. Stroit. Keram., No. 24, 105-27(1964). 48p. Dep. CFSTI. JCL $4.60 fs, $1.64 mf.

Sintering of mullite ceramics was studied under two regimes: sintering combined with synthesis of mullite from the starting oxides; and sintering of mullite previously synthesized from oxides at three different temperatures (beginning and end of mullitization and beginning of sintering) and subjected to fine milling before the second firing. Previous reports of expansion (arrest of densification) during mullite formation, and of an arrest of sintering in the high-temperature region at 19 to 24% porosity in the case of combined sintering and synthesis, were confirmed. It is proposed that expansion during mullite synthesis is due to asymmetric diffusion of mullite-forming oxides and that the arrest of sintering in the high-temperature region, in the one-stage process, is due to expansion and to the formation of a framework during mullitization. The two-stage regime ensures full densification, owing primarily to the fine milling of the material. Dense mullite material obtained from pure oxides by the two-stage process is said to be superior to glass-containing mullite refractories. (auth)

31073 (WAPD-Trans-61) PRODUCTION OF THIN-WALLED THORIUM OXIDE CERAMIC BODIES OF HIGH DENSITY BY SLIP CASTING. Ullmann, H.; Naumann, D.; Burk, W. Translated for Bettis Atomic Power Lab., West Mifflin, Pa., from Silikattechnik, 17: 209-11(1966). 12p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Optimum conditions for preparing ThO_2 ceramic bodies with high sintered density were selected from examples found in the literature, and a suitable slip casting procedure for producing very thin-walled bodies was developed. The basic character of the raw material and thus its proclivity by hydration was considered with special emphasis. (P.C.H.)

31074 HIGH-PRESSURE, HIGH-TEMPERATURE CERAMIC STRUCTURES. Clougherty, Edward V.; Kalish, David (Man-Labs, Inc., Cambridge, Mass.). pp 431-43 of Strengthening Mechanisms: Metals and Ceramics. Burke, John J.; Reed, Norman L.; Weiss, Volker (eds.). Syracuse, N. Y., Syracuse University Press, 1966.

From 12th Sagamore Army Materials Research Conference, Raquette Lake, N. Y., Aug. 24-27, 1965. See CONF-650846.

High-pressure hot-pressing, a fabricating procedure that uses pressure of the order of 100,000 psi and temperatures in the range 1500 to 2000°C, was used to prepare dense samples of transition metal diborides, TiB_2 and ZrB_2, without lower-melting metal additives. The microstructural characteristics of these materials are presented and are correlated with measured mechanical property data. Complementary analyses are also presented for materials fabricated by conventional hot-pressing. (auth)

31075 PREPARATION OF METAL-OXIDE DISPERSION COMPOSITES. Bufferd, Allan S. (New England Materials Lab., Inc., Medford, Mass.). pp 531-48 of Strengthening Mechanisms: Metals and Ceramics. Burke, John J.; Reed, Norman L.; Weiss, Volker (eds.). Syracuse, N. Y., Syracuse University Press, 1966.

From 12th Sagamore Army Materials Research Conference, Raquette Lake, N. Y., Aug. 24-27, 1965. See CONF-650846.

The methods and processes for the preparation of metal-oxide dispersion composites, which have been significantly utilized either commercially or in research and development, are reviewed. These procedures include surface oxidation of powders, internal oxidation, coprecipitation, electrodeposition, salt decomposition, and others. The methods are described in terms of their advantages and limitations with examples of various metal and alloy systems. (61 references) (J.G.B.)

31076 CRITERIA FOR THE SELECTION OF ADDITIVES TO ENABLE THE SINTERING OF ALUMINA TO PROCEED TO THEORETICAL DENSITY. Warman, M. O.; Budworth, D. W. (Univ. of Sheffield, Eng.). Trans. Brit. Ceram. Soc., 66: 253-64(June 1967).

It is suggested that volatility is an important characteristic of additives which enable alumina to sinter to theoretical density, and experiments which demonstrate that MgO and NiO can inhibit exaggerated grain growth in alumina after transport through the vapor phase are described. It is also shown that NiO, ZnO, CoO, and SnO_2 enable alumina to be sintered to theoretical density if the sintering atmosphere is correctly chosen. In the case of SnO_2, where there is no compound formation, the microstructure of the resulting specimens is different from that found in the systems where spinel formation is possible. A trial with magnesium aluminate spinel addition resulted in a fully dense specimen. A relationship between the sintering effects and the chemistry of various additives is thus shown to exist. (auth)

31077 EFFECTS OF RESIDUAL GAS ON THE SINTERING OF ALUMINA TO THEORETICAL DENSITY IN VACUUM. Warman, M. O.; Budworth, D. W. (Univ. of Sheffield, Eng.). Trans. Brit. Ceram. Soc., 66: 265-71(June 1967).

Experiments on the effects of heating-rate, residual gas pressure, specimen size, green density, and magnesia content on the sintering of alumina in vacuum are described. It was found that bloating occurs unless the conditions are correctly chosen. For a particular specimen size and heating rate there is a critical pressure below which the specimen must be evacuated before firing if theoretical density is to be achieved. Similar effects were also produced when firing in hydrogen, and it is suggested that the findings may be relevant to the problems encountered when scaling-up laboratory experiments for production. (auth)

31078 FINELY DIVIDED CARBIDES AND PROCESS FOR THEIR PRODUCTION. (to CIBA Ltd.). British Patent 1,069,748. May 24, 1967. Priority date Aug. 13, 1963, Switzerland.

A process for production of finely powdered nonpyrophoric carbides of B, Si, Ti, Zr, Hf, V, Nb, Ta, Mo, W, Th, and U is described. The process comprises subjecting gaseous halides of the elements to hydrocarbon reactions at 2000 to 5000°C. (J.R.D.)

31079 PRODUCTION OF STOICHIOMETRIC TITANIUM AND ZIRCONIUM HYDRIDE POWDERS. Oka, Akira. British Patent 1,070,022. May 24, 1967. Filed Dec. 16, 1964.

Methods for producing ultra fine powders of stoichiometric Ti or Zr hydrides are described. The metals are heated in H_2 at low pressure followed by cooling. The hydrides formed by this process are pulverized and degassed. (J.R.D.)

31080 METHOD OF PREPARING HIGH-DENSITY, COMPACTIBLE URANIUM DIOXIDE PARTICLES. (to U. S. Atomic Energy Commission). British Patent 1,065,742. Apr. 19, 1967. Priority date Dec. 24, 1963, United States.

A method is described for preparing high density UO_2 particles suitable for fabrication into fuel elements by vibratory packing. The method comprises precipitation of hydrous UO_2 from an aqueous solution of tetravalent U ions by the addition of an alkaline reagent. The precipitate is washed with water, dried at below 130°C, and fired at 1050°C. All operations are conducted under a non-oxidizing atmosphere and remote control of process steps is facilitated. (P.G.C.)

Properties Evaluations

Refer also to abstracts 30401, 31009, 31025, 31074, and 31103.

31081 (GEMP-528) VAPOR PRESSURE OF HYPOSTOICHIOMETRIC URANIA AS A FUNCTION OF COMPOSITION. Szwarc, R.; Latta, R. E. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). June 19, 1967. Contract AT(40-1)-2847. 25p. (CONF-670417-2). Dep. CFSTI.

From 69th Annual Meeting of the American Ceramic Society, New York.

The vapor pressure of hypostoichiometric UO_2 was measured as a function of temperature for a series of compositions. Data were obtained by means of an entrainment technique, in which weight loss of a specimen vaporizing at high temperatures in a stream of carrier gas is followed continuously using a recording thermobalance. By use of suitable atmospheres, constant vaporizing compositions were achieved, which vaporize pseudo-congruently. The following equations for the vapor pressure were obtained: for $UO_{1.88}$, $\ln P\ (atm) = 15.2 \pm 0.4 - (59{,}100 \pm 1{,}000/T)$; for $UO_{1.92}$, $\ln P\ (atm) = 14.6 \pm 0.6 - (59{,}200 \pm 1{,}700/T)$; and for $UO_{1.94}$, $\ln P\ (atm) = 15.1 \pm 1.5 - (61{,}000 \pm 1{,}500/T)$. (auth)

31082 (IS-T-128) PLASTIC DEFORMATION BEHAVIOR IN IRON-SILICON ALLOYS. Lakso, Gordon Everett (Ames Lab., Iowa). Nov. 1966. Contract W-7405-eng-82. 118p. Dep. CFSTI.

Thesis.

Polycrystalline iron–silicon alloys containing from 0 to 25 at. % Si were compressed at various temperatures and the corresponding true stress-true strain curves were recorded. Alloys containing less than 10.3 at. % Si were found to contain only short range order. This short range order increased both the slip and twinning stresses as the Si content of these alloys increased. On the other hand, a competitive effect due to a decrease in stacking fault energy with increasing Si favored twinning. Alloys with Si concentrations greater than 11.2 at. % contained only DO_3-type long range order. Depending on composition or temperature the stress-strain curves associated with these alloys showed either three stages of work hardening, i.e., stages I, II, and III or only one stage, i.e., stage III. Stage I has been attributed to the movement of perfect superlattice dislocations with essentially no interaction between them. Stage III, on the other hand, is due to the motion of imperfect dislocations through the lattice with the resultant production of first or second nearest-neighbor antiphase boundaries. All of the above results have been substantiated theoretically. The polycrystalline aspect of this investigation was extended to include single crystals. Specifically single crystals of Fe_3Si were oriented for single and double slip. In the case of the alloy oriented for single slip, one or three stage deformation was observed, depending on temperature, similar to that observed in polycrystals. Transmission electron microscopy investigations made on specimens cut from these crystals verify the prediction made in Part I. In addition, the stage II hardening has been attributed to Taylor type locking of superlattice dislocations. Work hardening rates approaching that of the elastic limit were observed in the Fe_3Si single crystal oriented for double slip. This has been attributed to the difficulty associated with bowing out superlattice dislocations between the forest dislocations on the second slip system. Also, a number of unique contrast mechanisms associated with the observation of dislocations and antiphase boundaries have been investigated. (auth)

31083 (LA–3652) CARBIDE–GRAPHITE COMPOSITES. Second Progress Report. Davidson, K. V.; Riley, R. E.; Taub, J. M. (Los Alamos Scientific Lab., N. Mex.). Sept. 26, 1966. Contract W-7405-eng-36. 15p. Dep. CFSTI.

Data on the effect of composition, binder content, and contaminants in the as-received carbide and graphite powders are presented. The effect of pressure on deformation of extruded composites at high temperatures is discussed. Also presented are preliminary determinations of the effect of composition of TaC–C composites, TaC–NbC solid solution, and composites of TaC–NbC mixtures. Preliminary data on the dynamic elastic properties and electrical resistivity of NbC–C composites are given. (auth)

31084 (LA–3693) CMF-13 RESEARCH ON CARBON AND GRAPHITE. Report No. 1. Summary of Progress to May 1, 1967. Smith, Morton C. (Los Alamos Scientific Lab., N. Mex.). May 1967. Contract W-7405-eng-36. 20p. Dep. CFSTI.

Research was undertaken on carbon and graphite to determine their behavior as engineering materials, to improve the raw materials and techniques involved in their manufacture. Micromerograph size-distribution analyses, surface area analyses, and density measurements were made on filters of coke flour and graphite flour. Research is being carried out on binders used for industrial carbons and graphites. Experiments were undertaken to examine the effects of various blending procedures on extruded and molded products of both resin-bonded and pitch-bonded graphites. Samples from a number of extruded graphite rods were examined to evaluate their crystalline anisotropies. Measurements of density, bulk velocity, shear velocity, Young's modulus, and internal friction were made on two samples of molded graphite. Tensile properties were determined for various samples. (M.C.G.)

31085 (N–67–14924) DEVELOPMENT OF PROTECTIVE COATINGS FOR ^{22}Ta ALLOY. Final Summary Report. Ortner, M. H.; Klach, S. J. (Vitro Labs., West Orange, N. J.). Dec. 1966. Contract NAS3-7613. 123p. (NASA-CR-54578). CFSTI $3.00 cy, $0.65 mn.

A variety of single phase and binary intermetallic compounds was electrophoretically deposited upon Ta T-222 alloy both with and without intervening barrier layers of W and Re. These coatings were tested for long term, one atmosphere cyclic oxidation resistance at 1500 and 2400°F. Promising systems were examined in more detail by metallography and by electron microprobe analysis. Of the systems studied to date, $MoSi_2$–30VSi_2 has yielded the best results. Two of eight samples of this coating survived 600 hours exposure at both 1500 and 2400°F, including approximately 30 cycles to room temperature without failure. Other binary silicide systems containing either WSi_2 or $MoSi_2$ combined with 3 to 30%$CrSi_2$ or $TiSi_2$ have performed well at 2400°F, but are subject to test failure at the lower test temperature. (auth)

31086 (NASA-CR–806) STABILIZATION OF CARBON AND NITROGEN IN STAINLESS STEEL AND ITS EFFECT ON MASS TRANSFER IN A STAINLESS STEEL–Cb–1Zr–POTASSIUM SYSTEM. Harrison, R. W. (General Electric Co., Cincinnati, Ohio, Missile and Space Div.). June 1967. Contract NAS3-6012. 38p. CFSTI.

Systems presently under investigation for space power generation in excess of 100 kW are of refractory alloy construction and employ alkali metals as working fluids. The use of stainless steel, rather than refractory alloys, for space power plant radiator construction and for the lower temperature portion of experimental facilities would constitute considerable material and fabrication cost savings. However, in such a bimetallic system the major uncertainty and limitation arise from the mass transfer of the interstitial elements, carbon and nitrogen, from the stainless steel to the refractory alloys through the alkali metal. Therefore, studies were made on the stabilization of C and N in stainless steel by the addition of metallic elements which form carbides and nitrides of high thermodynamic stability. Commercially available, Ti stabilized Type 321SS is one such alloy. A comparative investigation of this alloy and Type 316SS (a non-stabilized alloy) was performed to determine whether the Ti addition would reduce or eliminate interstitial element mass transfer in a stainless steel–Nb–1Zr alloy–liquid K system. Nb–1% Zr alloy specimens were exposed to liquid K in Type 321SS and Type 316SS capsules for 1000 hours at 1400°F under isothermal conditions. The capsules were filled with high purity, vacuum distilled and hot trapped K with an O content less than 20 ppM and sealed by electron beam welding in a high-vacuum chamber. The capsule exposures were conducted in an air environment. Post-test vacuum fusion and combustion-conductivimetric analyses, for N and C, respectively, showed evidence of extensive mass transfer in Nb–1Zr–Type 316SS capsules. No detectable interstitial increase was found in the Nb–1Zr specimens exposed in Type 321SS capsules. Changes in the room temperature and high temperature mechanical properties of the Nb–1Zr alloy specimens were consistent with the observed changes in chemical composition. (auth)

31087 (NYO–2581–7) FUNDAMENTAL STUDIES IN HIGH-TEMPERATURE MATERIALS PHENOMENA. Annual Progress Report. Bell, M. E.; Cross, L. E.; Mulay, L. N.; Barsch, G. R. (Pennsylvania State Univ., University Park. Materials Research Lab.). Mar. 1967. Contract AT(30-1)-2581. 37p. Dep. CFSTI.

Developments are reported for studies on dielectric, nonlinear elastic, and magnetic properties of inorganic salts, primarily TiO_2. Studies were also made on ordering of point defects in high temperature oxides. (P.C.H.)

31088 (ORNL-4121) THERMAL CONDUCTIVITY MEASUREMENTS ON SOLIDS BETWEEN 20 AND 150°C USING A COMPARATIVE-LONGITUDINAL APPARATUS: RESULTS ON MgO, BeO, ThO_2, $Th_xU_{1-x}O_{2+y}$ AND $AlUO_2$ CERMETS. Moore, J. P.; Kollie, T. G.; Graves, R. S.; McElroy, D. L. (Oak Ridge National Lab., Tenn.). June 1967. Contract W-7405-eng-26. 44p. Dep. CFSTI.

A comparative-longitudinal apparatus that can be used to measure the thermal conductivity of small uninstrumented specimens from room temperature to 150°C is described in detail. An error analysis is presented which indicates a measurement uncertainty of from ±2 to ±3%. In foils were selected to decrease the interfacial thermal resistance between the specimen and the meter bars. It was found that the interfacial resistance with In foils decreased with increasing pressure in the range from 70 to 5000 psi and was independent of temperature from 20 to 130°C. Thermal conductivity measurements were made on MgO, sol-gel ThO_2, and oxalate-ThO_2 specimens for a variety of densities, and the results compared to the equation, $K_m/K_{T.D.} = (1 - \rho')/(1 + \beta\rho')$, where K_m is the measured thermal conductivity, $K_{T.D.}$ is the thermal conductivity of theoretically dense material, and ρ' is the pore volume fraction. Experimental values of β obtained for MgO, solgel thoria, and oxalate ThO_2 were 1, 6.5, and 1.2, respectively. Thermal conductivity measurements on $Th_xU_{1-x}O_{2+y}$ with values for (1-x) of 0.047, 0.061, and 0.063 indicated a conductivity nearly as high as pure ThO_2 when the specimens were sintered in hydrogen ($y \cong 0.0$) but about one-half that of thoria when sintered in air ($y \approx 0.03$). The effects of neutron irradiation on the thermal conductivity of BeO are described. Results on a series of cermets consisting of Al and UO_2 are compared to an expression derived by Eucken for the thermal conductivity of two-phase material. (auth)

31089 (UCRL-17330, pp 123-48) CERAMIC SCIENCE. (California Univ., Berkeley. Lawrence Radiation Lab.).

Developments are reported for studies on: sublimation of GaN and LaF_3; effects of light and oxygen content on evaporation rate of zinc oxide; sublimation of Mg_3N_2 in vacuo and in argon and nitrogen gases; effects of microstructure on deformation of polycrystalline MgO; creep of MgO single crystals and LiF polycrys-

tals; calculation of grain-boundary sliding contribution during creep; effects of LiF on hot pressing of MgO; densification mechanisms of MgO powder; phase distribution and liquid phase sintering in multiphase magnesia and forsterite bodies; diffusion of Fe and Ni into single crystal MgO; diffusion in systems containing CaO; reactions between metallic iron and cobalt oxide-bearing sodium disilicate glass; dissolution and diffusion of CoO and NiO into sodium disilicate glass; electrochemistry of glasses; Al—Al_2O_3 interfaces; effects of stress concentration on strength of model two-phase system; strength of two-phase model system with fiber reinforcement; chemical reactivity in Al_2O_3—glass composite; and permeation of monatomic gases through Al_2O_3. (P.C.H.)

31090 (USBM-RC-1288) QUARTERLY METALLURGY PROGRESS REPORT NO. 34, JANUARY 1–MARCH 31, 1967. (Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center). Contract AT(11-1)-599. 38p. Dep. CFSTI.

Developments are reported for studies on high melting point carbides; Th alloy systems; UC–UN–UO in production of high temperature reactor fuels; and preparation and properties of W–Re–Mo alloys. (P.C.H.)

31091 MICROSTRUCTURE AND ITS INFLUENCE ON STRENGTH. Spriggs, R. M. (Lehigh Univ., Bethehem, Pa.). pp 181-218 of Strengthening Mechanisms: Metals and Ceramics. Burke, John J.; Reed, Norman L.; Weiss, Volker (eds.). Syracuse, N. Y., Syracuse University Press, 1966.

From 12th Sagamore Army Materials Research Conference, Raquette Lake, N. Y., Aug. 24–27, 1965. See CONF-650846.

A brief review of the effects of traditional microstructural variables (e.g., porosity and grain size) on the strength of single-phase polycrystalline ceramics is presented. It has been tentatively established that a major route toward improved mechanical properties is the development of fabrication techniques that result in pore-free ceramics with ever-decreasing grain sizes. Recent results are summarized for the interrelations among pressure-sintering processing in the low-to-high pressure regimes, resulting microstructures, and strengths, particularly for near-submicron grain size ceramic oxides. While strength increases with decreasing grain size appear to be limited by structural subtleties from processing, considerable relative strengthening is possible with processing variations and post-fabrication treatments (thermal, thermomechanical). An innovation in the mechanism of strengthening of dense fine-grained ceramics as a result of extensive thermomechanical working (termed press-forging) is proposed. This hypothesis suggests the possibility of dispersion-(or precipitation-) hardening caused by the simultaneous generation of dislocations and nucleation of a solute during the press-forging process. (auth)

31092 DISPERSION-STRENGTHENED CERAMICS. Whalen, T. J.; McHugh, C. O.; Humenik, M. Jr. (Ford Motor Co., Dearborn, Mich.). pp 219-27 of Strengthening Mechanisms: Metals and Ceramics. Burke, John J.; Reed, Norman L.; Weiss, Volker (eds.). Syracuse, N. Y., Syracuse University Press, 1966.

From 12th Sagamore Army Materials Research Conference, Raquette Lake, N. Y., Aug. 24–27, 1965. See CONF-650846.

A dispersion of metallic particles in ceramics can be used to control grain growth, and thus indirectly strengthen ceramic materials. Fine Mo particles were found to inhibit grain growth and secondary recrystallization in Al_2O_3 during sintering. Specimens with up to 10 volume percent Mo were fabricated by conventional powder metallurgy techniques. Three process methods were used to disperse the Mo, and the microstructures resulting from the different processes are discussed. Grain refinement from the metallic inclusions enhanced the strength of Al_2O_3. (auth)

31093 CERAMIC-METAL FIBER COMPOSITE SYSTEMS. Tinklepaugh, J. R. (State Univ. of New York, Alfred). pp 579-98 of Strengthening Mechanisms: Metals and Ceramics. Burke, John J.; Reed, Norman L.; Weiss, Volker (eds.). Syracuse, N. Y., Syracuse University Press, 1966.

From 12th Sagamore Army Materials Research Conference, Raquette Lake, N. Y., Aug. 24–27, 1965. See CONF-650846.

Studies on the strengthening of certain ceramic materials by reinforcing them with high-modulus refractory metal fibers are reviewed. The effects of differential thermal expansions of the ceramic and metal on the mechanical bond are discussed. Compatibility studies of various refractory metals and ceramic materials for fiber-reinforced ceramics are summarized. (J.G.B.)

31094 INTERNAL FRICTION IN ZIRCONIUM DIOXIDE AT TEMPERATURES IN THE RANGE 20 TO 1250°C. Kovalev, A. I.; Pechenezhskii, V. I. (Ukrainian Scientific-Research Inst. of Refractory Materials, Kharkov). Soviet Phys.-Solid State (Engl. Transl.), 9: 278-9(July 1967).

Translated from Fiz. Tverd. Tela, 9: 363-4(Jan. 1967).

Measurements were made of the internal friction of polycrystalline samples of zirconium dioxide containing 3.5, 6, 8.3, and 10.5% CaO. The measurements were made at frequencies of about 200 cps, and the magnitude of the internal friction was calculated from vibrograms of freely decaying vibrations of the sample, recorded on a loop oscilloscope. The samples had the form of prismatic bars of 8 × 8 × 120 mm dimensions with a 4 × 4 × 20 mm neck in the middle. Curves are plotted that indicate the temperature dependence of the internal friction of zirconium dioxide for the different amounts of the stabilizing additive CaO. (J.H.M.)

31095 STUDY OF SOME PROPERTIES OF SINTERED U_3Si_2. Huettig, W.; Mueller, E.; Steinkopff, H. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie, 10: 47-52 (Feb. 1967). (In German).

The data already published concerning the powder-metallurgical manufacture and sintering ability of U_3Si_2 are completed by the results obtained in studying properties of sintered U_3Si_2 materials such as resistance to thermal cycling, oxidation, corrosion, and compatibility between U_3Si_2 and Fe. (auth)

31096 ENTHALPY AND HEAT CAPACITY OF ZIRCONIUM DIOXIDE IN THE TEMPERATURE INTERVAL 1100 TO 2500°K. Kirillin, V. A.; Sheindlin, A. E.; Chekhovskoi, V. Ya.; Zhukova, I. A.; Tarasov, V. D. (Scientific Research Inst. of High Temperature, USSR). Teplofiz. Vysok. Temp., 4: 878-9(Nov.-Dec. 1966). (In Russian).

ZrO_2 samples, prepared in the form of cylinders, were sealed in ampoules made of Mo. The chemical composition of the impurities in the samples was as follows: 0.05% Fe; 0.05% Ti; 2.3% HfO_2; 0.1% sulfates; 0.5% alkali metals; 0.02% chlorides. The temperature of the sample in the furnace was measured with a Type OP-48 optical pyrometer. The experimental results are plotted. The following empirical equations were established: (1) for the monoclinic modification of ZrO_2 in the temperature interval 1000 to 1420°K: $H_T - H_{273.15} = 0.4699T + 0.0678 \times 10^{-3}T^2 - 133.4$ kilojoules/kg; $c_p = 0.4699 + 0.1356 \times 10^{-3}T$ kilojoules/kg-degree and (2) for the tetragonal modification of ZrO_2 in the temperature interval 1420 to 2500°K: $H_T - H_{273.15} = 0.6393T - 174.6$ kilojoules/kg; $c_p = 0.6393$ kilojoules/kg-degree. (ATD)

31097 EXPERIMENTAL DETERMINATION OF THERMAL RESISTANCE OF HIGH-MELTING-POINT MATERIALS. Lanin, A. G.; Fedorov, V. B.; Egorov, V. S. Teplofiz. Vysok. Temp., 4: 865-71(Nov.-Dec. 1966). (In Russian).

Various methods and their limitations in test range, efficiency, and accuracy for measuring thermal resistance of ZrO, BeO, NbC, and TiC were investigated. Electron-beam heating proved most efficient and accurate of all methods tested. Other methods used were: radial thermal flux with indirect heating; heat cooling in liquid, vapor-gas and dust-gas media; and radiation heating-cooling method. (R.V.J.)

31098 ELASTIC CONSTANTS AND CHARACTERISTICS OF THE ELECTRONIC STRUCTURE OF CERTAIN TYPES OF REFRACTORY COMPOUNDS OBTAINED BY SINTERING. Frantsevich, I. N.; Zhurakovskii, E. A.; Lyashchenko, A. B. (Inst. of Materials Science Problems, Kiev). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 8-16(Jan. 1967). (In Russian).

The elastic constants, characteristic temperatures, and mean square displacements of atoms were determined for a series of refractory compounds (carbides, borides, silicides, and nitrides). In order to obtain values of the elastic constants for the material in a nonporous state, the elastic constants of samples of different porosities were extrapolated to zero porosity. From a study of the emission and absorption x-ray spectra, certain characteristics of the electronic structure (titanium, vanadium, and chromium carbides, borides, and silicides) were elucidated. A comparative analysis is given for the criteria of interatomic bond strength, elastic constants, and mean square displacements of atoms at the crystal lattice points and for the characteristics of the fine structure of emission x-ray spectra. These characteristics indicate the strengthening or weakening of the interatomic bond in crystal lattices of refractory compounds. (ATD)

31099 OXIDATION OF U_4O_9 DURING HEATING IN THE AIR. Bessonov, A. F.; Semavin, Yu. N.; Taksis, G. A. (Ural Polytechnic Inst., Sverdlovsk, USSR). Izv. Vyssh. Ucheb. Zaved., Tsvetn. Met., No. 2, 100-2(1967). (In Russian).

A block-diagram is given of a high-temperature, complex device capable of simultaneously taking x-ray pictures, electric resistance curves, linear dimension curves, and thermograms. Heating of the U_4O_9 specimen was accomplished within 0.12 degree/sec. The x-ray pictures were taken at 25 to 35° (0.43 to 0.60 RAD) angle intervals. The interplanar distances were significantly reduced during the transition of U_4O_9 to U_3O_7. Oxidation of U_4O_9 in U_3O_7 is

accompanied by an exothermal effect and the transformation of U_3O_7 into U_3O_8 results in increased electric resistance and dimensions of the specimen. (R.V.J.)

31100 SUPERCONDUCTIVITY OF SOLID SOLUTIONS OF TRANSITION METAL CARBIDES AND NITRIDES. Alekseevskii, N. E.; Samsonov, G. V.; Shulishova, O. I. (Inst. of Materials Science Problems, Kiev). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 61-6(Jan. 1967). (In Russian).

The temperatures of transition to the superconducting state were studied in systems of solid solutions TiC–NbC, ZrC–NbC, HfC–NbC, ZrC–TaC, HfC–TaC, HfC–MoC, TaC–MoC, NbC–NbN, and TaC–NbC, constituting a class of compounds with a fcc NaCl-type lattice. The transition temperatures were determined from the change in the mutual induction of the measuring coils on an alternating current bridge. All the values of the critical temperature were extrapolated to a zero magnetic field. For all systems except TaC–NbC, a nonlinear change of the critical temperature with the composition was established. The observed regularities in the change of the critical temperature in these solid solution systems are analyzed, and it is postulated that change of T_c with the composition results from a change in the density of the electron states. (ATD)

31101 SOME MECHANICAL PROPERTIES OF BORON–TUNGSTEN BORIDE FILAMENTS. Ellison, E. G.; Boone, D. H. (Pratt and Whitney Aircraft, North Haven, Conn.). J. Less-Common Metals, 13: 103-11(July 1967).

The creep strength of B filaments in vacuum is found to exceed that of W filaments. The ultimate tensile strength of the B filaments is shown to decrease with temperature especially above 1400°F. Measurements of the elastic modulus as a function of temperature are also made. With regard to the use of B filaments in a composite material, it is shown that the filaments are not chemically compatible with such a matrix as Ni but show negligible reaction with a Ti matrix at temperatures up to 1200°F. (auth)

31102 HIGH TEMPERATURE THERMOELECTRIC MATERIAL. (to U. S. Atomic Energy Commission). British Patent 1,073,865. June 28, 1967. Priority date Feb. 10, 1965, United States.

Preparation and uses of Mn_6Si_7 thermoelectric material are described. The compound is useful with heat sources producing temperatures at 300 to 1100°K. This compound has a higher figure of merit than other silicides and has a low neutron cross section. (J.R.D.)

Structure and Phase Studies

Refer also to abstracts 31009 and 31100.

31103 (NUMEC–3505-24) PuO_2–UO_2–ZrO_2 FUEL DEVELOPMENT PROGRAM. Progress Report, October 1–December 31, 1966. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Apr. 1967. Contract AT(30-1)-3505. 28p. (EURAEC–1853). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The first of a series of anneal-quench runs in support of the phase-diagram study was completed. Results of data analysis indicated that some stabilization of the structure may have occurred for single-phase compositions. The crystallographic structures of the phases present were proven to be of low symmetry. Contact autoradiographs and grain structures of each annealed pellet were prepared. Grain growth occurred for all compositions tested and the rates were higher at the center range compositions. Several as-sintered pellets were placed in a tube furnace at 1000°C in a moist N_2–7% H_2 atmosphere. This caused a significant increase in the void content of each composition except 10 vol % PuO_2–25 vol % ZrO_2 and 6 vol % PuO_2–75 vol % ZrO_2. There were evidences of second-phase grain growth in the grain boundary regions of every composition tested. Irradiation testing is continuing. (M.C.G.)

31104 NEUTRON-DIFFRACTION STUDY OF Ce_2C_3 AT LOW TEMPERATURES. Atoji, Masao (Argonne National Lab., Ill.). J. Chem. Phys., 46: 4148-9(May 15, 1967).

Neutron-diffraction studies were made on the crystal and magnetic structures of Ce_2C_3 at 4 to 300°K. The temperature dependency of the Ce_2C_3 lattice is shown; it suggests a gradual "lattice-collapsing" transformation ending at about 90 ± 5°K. Except for the difference in the Debye-Waller temperature factors, B = 0.47 ± 0.08 Å^2 at 300°K and B = 0.20 ± 0.08 Å^2 at 4°K, no significant modification of the atomic parameters was found in cooling Ce_2C_3 down to 4°K. The Ce_2C_3 patterns between 4 and 300°K showed no detectable coherent magnetic peak. (M.C.G.)

31105 STUDIES OF BINARY URANIUM OXIDES. Kovba, L. M.; Polunina, G. P.; Verbetskii, V. N.; Bikbulatov, E. S. Vestn. Moskov, Univ., Ser. II, Khim., No. 6, 29-32(Nov.-Dec. 1966). (In Russian).

The structure of double oxides of U and Fe was studied on specimens prepared by coprecipitation of the hydrated oxides followed by calcination. No single-phase precipitate was obtained; the Fe : U ratio of the system was found to be 1 : 2, corresponding to 3.5 ± 0.5 wt % of Fe_2O_3 and 6 ± 1 wt % of U_3O_8. Like the double oxides of Ti and Ni with U, the double oxide with Fe also crystallizes in the rhombic system. The exact position of the O atoms could not be determined and the thermal instability of the compound made it impossible to carry out single-crystal studies. The results of analytical determinations and the parameters of the double-oxide systems $UTiO_5$, NiU_3O_{10}, and FeU_3O_{10} are tabulated. (TTT)

Radiation Effects

Refer also to abstracts 31066 and 31088.

31106 (AD–643268) RADIATION EFFECTS IN SILICON AND GERMANIUM. Final Report. Curtis, O. L.; Bass, R. F.; Germano, C. A. (Nortronics, Newbury Park, Calif. Applied Research Dept.). Nov. 1966. Contract DA-49-186-AMC-235(X). 155p. (ARD–66-56R). CFSTI $3.00 cy, $0.65 mn.

Measurements indicate that O_2 concentration does not affect lifetime degradation in neutron-irradiated Si. Type and amount of dopant is also unimportant in n-type material and plays only a limited role in p-type Si with resistivities less than approximately 5 ohm-cm. The dependence of lifetime on both carrier concentration and temperature indicates that simple recombination theory is not followed; alternate possibilities for explaining the results are proposed. Carrier concentration and mobility in neutron-irradiated Si are more seriously affected by O_2, dopant, and possibly other factors, especially in n-type material. The dominance of the "disordered region" in recombination is indicated in several ways, including behavior of short-term annealing. Measurement of the dependence of lifetime on injection level has proved very effective in obtaining recombination level parameters. The dominant recombination level at low excitation in both neutron- and gamma-irradiated Ge has been found to be $E_r - E_v = 0.34$ eV with almost no dependence on dopant. Evidently the effective energy level position of the recombination center is unaffected by the disordered region. A second level at $E_c - E_r$ approximately 0.2 eV is required to explain the dependence of lifetime on injection level at high excitation. Comparison with measurements of the temperature dependence of lifetime indicates a temperature variation of electron capture probability. (auth)

31107 (AD–643783) DEVICE PERFORMANCE CHARACTERISTICS AS RELATED TO RADIATION DAMAGE IN SEMICONDUCTOR MATERIALS. Final Report, June 1965–June 1966. Messenger, George C.; Pretzer, Donavon D.; Chang, William W.; Kimble, Stewart G.; Steele, Edward J. (Nortronics, Newbury Park, Calif. Applied Research Dept.). Contract AF 19(628)-5113. 236p. (ARD–66-42-R; AFCRL–66-462). CFSTI $3.00 cy, $0.65 mn.

Radiation damage to bulk semiconductor materials and semiconductor devices has been investigated. Though the space radiation environment has been discussed, primary emphasis has been placed on the nuclear radiation environment since more experimental work has been done in the latter field. The Hall–Shockley–Read equations for describing minority carrier lifetime as a function of a single recombination level have been modified to account for the presence of two recombination levels. The resulting equations are in reasonably good agreement with the experimental work of O. L. Curtis on neutron damage to bulk silicon. The latest experimental work on radiation damage to bipolar transistors, semiconductor diodes, field effect transistors, and integrated circuits has been reviewed. Suggestions are included for establishing the minimum number of experimental and theoretical programs necessary to obtain the information required to eventually produce semiconductor devices which are relatively insensitive to the known radiation environments. (auth)

31108 (ORNL–4104) IRRADIATION BEHAVIOR OF Eu_2O_3–STAINLESS STEEL DISPERSIONS. Leitten, C. F. Jr.; Richt, A. E.; Beaver, R. J. (Oak Ridge National Lab., Tenn.). June 1967. Contract W-7405-eng-26. 45p. Dep. CFSTI.

Acceptable components were made for the SM-1 reactor with stainless steel containing less than 0.03% Si. Irradiation in the ETR verified that these mixtures of Eu_2O_3 with low-Si stainless steel remained stable through long exposures to thermal neutrons. Mixtures containing 20, 30, and 40 wt % Eu_2O_3 were tested to exposures ranging from 0.7×10^{21} to 4.5×10^{21} neutrons/cm^2 at a temperature estimated to be 150°F. No instabilities or reactions

were observed by microstructural examination and dimensional measurement. Eu_2O_3 is prone to attack when exposed to water. Irradiation did not appear to have any effect on this property. Mass spectrographic analyses of the Eu after irradiation indicated that the actual burnup of Eu was about an order of magnitude less than that predicted by unperturbed neutron flux values or ^{60}Co monitoring. (P.C.H.)

31109 (SC-RR-67-122) COMPUTER PROGRAM FOR DAMAGE CORRELATION IN SILICON. Gwyn, C. W.; Wirth, J. L. (Sandia Corp., Albuquerque, N. Mex.). June 1967. Contract AT(29-1)-789. 31p. Dep. CFSTI.

The displacement damage produced in Si by neutron irradiation is a function of the neutron energy spectrum. The results of several studies performed to determine the energy dependence of displacement damage in Si are reviewed, and a computer code that is used to calculate the damage ratio for two arbitrary neutron spectra is described. (auth)

31110 RELATIONSHIP BETWEEN ESR SPECTRA AND DOSE IN ELECTRON-IRRADIATED BOROSILICATE GLASSES. Reyes L., S.; Munoz P., E.; Reyes L., J. (Univ. Nacional de Mexico, Mexico City). Rev. Mex. Fis., 16: 31-8(1967).

Electron spin resonance (ESR) spectra have been observed for electron-irradiated Co-activated borosilicate glasses. The glasses were exposed to doses between 10^3 and 10^6 rad and display an ESR spectrum such that the intensity of the only line is an increasing function of the doses having a tendency to saturation. Graphs were obtained which show the decay of the paramagnetic centers. The relation between intensity and dose opens the possibility of using these glasses as dosimeters. The results have been compared with the usual method of optical density. (auth)

31111 GAMMA RADIATION EFFECTS ON THE HARDNESS OF GLASSES OF THE As_2Se_3–As_2Te_3 SYSTEM. Domoryad, I. A. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uz. SSR, Ser. Fiz.-Mat. Nauk, No. 2, 67(1967). (In Russian).

Specimens of As_2Se_3–As_2Te_3 with hardness of 126 kg/mm^2 were irradiated with γ rays with increasing doses up to 400×10^6 r with rates of 500 r/sec at 35°C. Their hardness increased to a saturation level of 145 to 150 kg/mm^2 after 250×10^6 r. (R.V.J.)

31112 EFFECTS OF GAMMA IRRADIATION ON THE CHARACTERISTICS OF A RUBY LASER. Johnson, V. R. (Microwave Electronics Corp., Palo Alto, Calif.); Grow, R. W. IEEE (Inst. Elec. Electron. Eng.) J. Quant. Electron., QE-3: 1-7(Jan. 1967).

A theoretical model describing the effects of γ irradiation on the energy levels and transition probabilities of the Cr^{3+} ions was proposed and used to predict the effect γ irradiation has on the efficiency and threshold energy characteristic of a ruby laser. It was shown that the absorption cross-section responsible for optical pumping of a ruby laser increases as a result of γ irradiation. As single crystal ruby was irradiated with ^{60}Co γ rays, the usual absorption bands which exist between 200 and 550 mμ changed from 4 distinct bands to one continuous absorption band. Similar work on sapphire, the host crystal for ruby, indicates that most of this increased absorption is experienced by the Cr^{3+} ion in ruby. Thermoluminescence data showed that electron traps with activation energies of about 0.64 and 0.78 eV are formed in ruby as a result of γ irradiation. These traps remain in the crystal until it is annealed at about 800°C. It was found that the threshold energy for laser action increases in relation to the amount of irradiation. This effect is also manifested as a decrease in the luminescence of the $\underline{R}_1$ line after γ irradiation. (BBB)

31113 DETERMINATION OF DOSE AND TEMPERATURE IN GRAPHITE IRRADIATION EXPERIMENTS IN THE DOUNREAY FAST REACTOR. Martin, W. H.; Price, A. M. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). J. Nucl. Energy, 21: 359-71(Apr. 1967). (TRG-Report-1260; JNPC-MWP-GSG/P(66)52; TRG-Report-1117; JNPC-MWP-GSG/P(65)82).

Two graphite irradiation experiments were performed in a pitch-30 position of the Dounreay Fast Reactor (DFR) core. The changes in dimensions and thermal conductivity of the graphite in these experiments were correlated with similar changes produced by irradiations in the Harwell Reactor Dido at known temperatures. This allowed determination of the relation between the damaging power of the neutron spectrum in this DFR position with that of the Dido spectrum. The relation is expressed in terms of the fast-neutron flux in the two reactors, using the reaction ^{58}Ni (n,p)^{58}Co. In order to produce the same state of damage in graphite the fast-neutron dose required in Dido was about twice that in the DFR position investigated. In the DFR experiments silicon carbide specimens were included with the object of estimating irradiation temperatures. It was concluded, from the results of measurements made on these specimens and from a comparison of DFR and Dido data, that an equivalent temperature correction is necessary for dimensional changes over the full range of temperatures covered by the DFR experiments. It cannot be concluded whether a similar correction is necessary for thermal conductivity changes for DFR irradiation temperatures above 600°C. (auth)

31114 IRRADIATION EFFECTS IN GLASSES: SUPPRESSION BY SYNTHESIS UNDER HIGH-PRESSURE HYDROGEN. Faile, S. P.; Schmidt, J. J.; Roy, D. M. (Pennsylvania State Univ., University Park). Science, 156: 1593-5(June 23, 1967).

Glasses synthesized under high pressure of H_2 showed resistance to certain effects of irradiation. Paramagnetic and light-absorption effects associated with irradiated glasses were diminished by a factor as large as 20 in some glasses. Irradiation increases the concentration of hydroxyl ions, as evidenced by increased absorption in the 2.7-micron (3700 cm^{-1}) infrared region for hydrogen-silica glasses. (auth)

31115 EFFECT OF α-IRRADIATION ON THE MICROPLASTICITY OF QUARTZ GLASS. Troitzkii, O. A.; Terekhova, N. B. (Inst. of Solid State Physics, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 200-2(Jan. 1967). (In Russian).

The effects of α-irradiation with ^{239}Pu (particle energy 5.14 MeV) on the microplasticity of quartz glasses were studied by means of microhardness measurements in which the length of the diagonal in indentations made with a diamond pyramid was determined. Both the indenter and the α particles penetrated the glasses to approximately the same depth (10 to 12 μ). Gauss distribution curves of the microhardness values for deformation of the glass with and without irradiation showed that the field of external α radiation causes a decrease in microhardness or increase in the microplasticity of quartz glass. The number of atoms displaced under the influence of the α bombardment was calculated to be approximately 2.76×10^9 atoms/cm^3 sec. From the thermodynamic standpoint, the irradiation affects the strength of the glass by changing the free surface energy of the glass. (ATD)

31116 EFFECT OF IRRADIATION WITH THERMAL NEUTRONS ON CERTAIN ELECTRIC PROPERTIES OF CERAMICS FROM PURE ALUMINUM OXIDE. Budnikov, P. P.; Kerbe, F. G.; Kostyukov, N. S. (Moscow Chemical Engineering Inst.). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 94-100(Jan. 1967). (In Russian).

The effect of thermal neutrons on the radiation resistance and electric parameters of corundum ceramics was studied. Analysis of the nuclear reactions taking place (formation of the short-lived ^{19}O and ^{28}Al isotopes) shows that corundum can be recommended for use in thermal-neutron fluxes. It is shown that only very high integrated thermal-neutron fluxes of the order of 10^{21} n/cm^2 and higher have a very substantial effect on the electrophysical parameters of corundum: the electric conductivity, dielectric constant, and the dielectric-loss factor and loss tangent are increased. This effect may cause a considerable decrease of the insulating properties of corundum. Such radiation defects are stable and are not annealed at high temperatures. (ATD)

Plastics and Other Materials

31117 (LA-3664) PREPARATION OF HIGH DENSITY GRAPHITE BY HYDROSTATIC PRESSING. Schell, D. H.; Wertz, L. A. (Los Alamos Scientific Lab., N. Mex.). Dec. 8, 1966. Contract W-7405-eng-36. 16p. Dep. CFSTI.

Graphite pieces were made by hydrostatically pressing a thermosetting plastic bonded mix and processing the pressings through a 2500°C graphitizing treatment. Pressings made with 85 parts graphite flour and 15 parts Thermax bonded with Varcum had densities around 1.8 g/cc and compressive strengths around 9000 psi. This investigation included the use of different filler materials, binders, and processing variables in an attempt to optimize density and strength. (auth)

31118 ELECTRIC BREAKDOWN VOLTAGE IN ELECTRON-IRRADIATED POLYVINYL CHLORIDE. Reyes Lujan, Javier; Reyes Lujan, Sergio A. (Univ. Nacional de Mexico, Mexico City). Rev. Mex. Fis., 16: 57-71(1967). (In Spanish).

The relationship between the electric breakdown voltage and dose in electron-irradiated polyvinyl chloride films in the range of 0.6 to 1.0 MeV and 0.1 to 5 Mrad is studied. Using electron spin-resonance techniques, the relative concentration of free radicals in the films is determined. The relationship between the concentration of free radicals and the electric breakdown voltage is shown and the variation of concentration in time is analyzed. (auth)

31119 RADIATION EFFECTS IN p-SILICON. Eritsyan, G. N.; Konozenko, I. D.; Khivrich, V. I. (Inst. of Physics, Moscow). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 2: 141-2(1967). (In Russian).

In the results of the Hall measurements of p-Si, after irradiation by γ quanta, it has been observed an anomalous increase of the mobility and a change of law of dependence of the mobility upon the temperature. (auth)

31120 γ-RAY RADIATION DAMAGE IN TURBINE LUBRICATING OILS. Moniwa, Yoshihiro; Nakamura, Go (Hitachi Ltd., Tokyo). Hitachi Hyoron, 48: No. 7, 5-9(July 1966). (In Japanese).

Samples of turbine-lubricating oils were exposed to γ rays and the resulting deteriorations of the materials were examined. A 1 to 5×10^8 γ dose was given to a 20-g sample contained in a tube 12.5 cm from the 10,000-C ^{60}Co source. After irradiation, the color index, specific gravity, viscosity, I value, acid value, flash point, boundary friction coefficient, and IR spectrum were measured. Results show that the deterioration of the oil cannot be prevented even if the aromatic content is increased; changes occur in the color index and viscosity, but not in other properties; in the IR spectrum, changes occur at 965, 910, and 885 cm^{-1}, with the intensities being increased after radiation; and the oxidation deterioration tends to proceed after irradiation when the sample is left in the air. If a viscosity change of 2% is permissible, the corresponding dose is about $1-2 \times 10^8$ γ. (NSA of Japan)

PHYSICS (GENERAL)

Astrophysics

Refer also to abstracts 31237, 31238, 31275, 31276, 31292, 31306, and 31704.

31121 (AD-634918) RESEARCH ON RELATIONS BETWEEN COMETARY, SOLAR, AND UPPER ATMOSPHERIC PROCESSES. Annual Summary Report No. 4, April 1, 1965–March 31, 1966. Swings, Pol (Liege Univ. (Belgium)). Apr. 25, 1966. Contract AF 61(052)-587. 34p. (AFCRL-66-433). CFSTI.

Laboratory work was carried on: the time resolution of spectra; the spectra of several molecules of astronomical interest; various instruments; the study of photomultipliers. The physical mechanisms in comets are discussed. Other programs of cometary and solar investigations were started. Investigations related to space experiments are mainly concerned with the far ultraviolet spectra of stars, comets, and aurorae, and with artificial comets. (auth)

31122 (ARL-67-0053) RESEARCH ON SOLUTIONS OF THE GRAVITATIONAL FIELD EQUATIONS. Newman, Ezra T.; Janis, Allen I. (Pittsburgh Univ., Pa.). Mar. 1967. Contract AF33 (615)-1523. 144p. CFSTI.

This research is primarily concerned with gravitational radiation problems and related phenomena. The work can be broadly classified into two main categories: (I) exact solutions of the Einstein field equations and their properties, and (II) asymptotic behavior of solutions, with subclasses: (a) asymptotic structure, e.g., multipole moments, (b) scattering of gravitational radiation, (c) asymptotic symmetries, i.e., the Bondi–Metzner–Sachs group, and (d) conservation laws, in particular those recently discovered by Newman and Penrose. (auth)

31123 MASS DEPENDENCE IN GRAVITATIONAL COLLAPSE OF STELLAR CORES. Arnett, David (Goddard Space Flight Center, New York). Can. J. Phys., 45: 1621-41(May 1967).

The mass dependence of the behavior of a stellar core undergoing gravitational collapse is examined, using an improved equation of state and improved mean-free path for energy transfer by neutrinos and antineutrinos. Energy loss due to the escape of muon-type neutrinos is included. For $M_{core} \sim 2M_\odot$ and $4M_\odot$ there is explosive mass ejection. A neutron-star remnant of $0.56M_\odot$ is left in the $2M_\odot$ case, while in the $4M_\odot$ case the remnant mass is $2.46M_\odot$. Upon cooling, the latter remnant may not be able to remain stable because of general relativistic effects. For $M_{core} \sim 8M_\odot$ and $32M_\odot$ the models were too opaque to electron-type neutrinos to eject matter. In both cases they cooled by copious muon-type neutrino emission (to which they were transparent) and developed dense ($\rho \gtrsim 10^{15}$ g/cc) central regions in which general relativistic effects became important. It appears that highly evolved stars with $M_{core} \gtrsim 4M_\odot$ may not be able to avoid the Schwarzschild singularity of general relativity. (auth)

31124 LUNAR OCCULTATION STUDIES OF FIVE WEAK RADIO SOURCES OF SMALL ANGULAR SIZE. Hazard, C.; Gulkis, S.; Bray, A. D. (Cornell Univ., Ithaca, N. Y.). Astrophys. J., 148: 669-87(June 1967).

An investigation of five small-angular-size sources based on occultation observations made with the 1000-foot steerable telescope at Arecibo is described. All the sources contain structures ≤1″, and at least three appear to possess a double structure similar to that of 3C 273. Only one source reveals no evidence of resolution or of complex structure, and for this source only one occultation curve was observed. Identifications are proposed for four of the five sources investigated, but for the remaining source there is no object within the plate limits near the source position. All objects are faint, three being close to the plate limits with a magnitude ≥20. It is suggested that all are probably quasi-stellar radio sources, a suggestion which is supported by the recent measurement of the redshift (z = 1.47) of the brightest of the new identifications. It appears probable that the remaining sources are at even greater distances. The extension of the observations to fainter sources, which will soon be possible using a new telescope feed now under construction, should permit an investigation of the structure of objects with redshifts in excess of 2, when a test of certain classes of cosmology should then become feasible. (auth)

31125 THE MILLIMETER RADIATION FROM 3C 273. Stein, Wayne A. (Univ. of California, San Diego). Astrophys. J., 148: 689-94(June 1967).

The spectrum of 3C 273 in early 1965 as shown by Low and by Epstein, Oliver, and Schorn at millimeter wavelengths is examined. Restrictions placed on the possible models of 3C 273 as a result of these observations are investigated. It is shown that, if the size of the object is determined by the time variations, then, because of synchrotron self-absorption, the observed flux is inconsistent with a distance of 3C 273 as large as 470 Mpc. Possible ways of avoiding this conclusion are also discussed. (auth)

31126 THE EMISSION-LINE SPECTRUM OF 3C 273. Wampler, E. J. (Lick Observatory, Mt. Hamilton, Calif.); Oke, J. B. Astrophys. J., 148: 695-704(June 1967).

An accurate photoelectric spectrophotometric study of the spectrum of 3C 273 has verified the existence of a number of emission features previously unknown or only suspected. The evidence is strong that most of these features are emission lines of Fe II, with one other being the sodium D-lines. The presence of Fe II lines, together with the absence or extreme weakness of [Fe II] lines, indicates that the electron density in the optically emitting region is greater than 10^6 cm^{-3} and probably greater than 10^7 cm^{-3}. It is found that the volume of gas which produces the hydrogen lines can also produce the Fe II lines provided $X_{Fe\ III}/X_{Fe\ II} = 300$. The degree of ionization of Mg II should be very similar to that of Fe II; assuming the same value as above, namely, $X_{Mg\ III}/X_{Mg\ II} = 300$, one obtains the incorrect intensity of λ2798. If the chemical abundances are similar to those in the Sun, it is predicted that the ultraviolet flux F_ν should be a factor 100 less than in the visual. Several detectable absorption lines of Fe II should exist in the neighborhood of λ2500. (auth)

31127 ON THE INTERPRETATION OF THE UBV MEASUREMENTS OF QUASI-STELLAR SOURCES. Grewing, Michael (Univ., Bonn). Astrophys. J., 148: 705-12(June 1967).

The two-color diagram for thirty-seven quasars is discussed. Deviations from a predicted relation as given by Matthews and Sandage are qualitatively explained as being due to the influence of the emission lines. Use is made of the sensitivity functions for the UBV system as well as of estimated line intensities. The recently published UBV data for the object 3C 446 are analyzed. It turns out that the (U−B) and (B−V) values approached the line predicted for objects emitting undisturbed synchrotron radiation, while, at the same time, the emission features that were clearly visible in 1965 became practically undetectable. The spectra index following from the UBV data is shown to be significantly larger than the one determined from the flux measurements in the radio-frequency range. (auth)

31128 UPPER LIMIT ON THE MEAN MASS DENSITY DUE TO GALAXIES. Peebles, P. J. E.; Partridge, R. B. (Princeton Univ., N. J.). Astrophys. J., 148: 713-17(June 1967).

It is shown that present observations of the brightness of the night sky in the visible fix a useful upper limit to the mean mass density due to luminous matter in the Universe. If the material has a mass-to-luminosity ratio of 20 solar units, this upper limit is four times lower than the density needed to close the Universe. (auth)

31129 THE NATURE OF THE REMARKABLE GALAXY G.R. 8. Hodge, Paul W. (Univ. of Washington, D. C.). Astrophys. J., 148: 719-25(June 1967).

The irregular galaxy G. R. 8 is found to be an extremely small galaxy, possibly close enough to be considered a local group member. Its mean dimension is on the order of only 100 pc. Photoelectric measurements show that it is considerably bluer than any other measured (non-quasi-stellar) galaxy, and that its color–magnitude diagram is like that of a very young, not very populous open cluster. Its luminosity function contains only one hundred stars in the top five magnitudes, and no H II regions have been detected. Its structure, as revealed by isophotes constructed from photoelectric and photographic photometry, is like that of other irregular galaxies; an approximately exponential decrease of brightness characterizes the outer, unresolved portions. (auth)

31130 OBSERVATIONS OF GALACTIC OH. Palmer, Patrick; Zuckerman, B. (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J., 148: 727-44(June 1967).

The 140 foot radio telescope of the National Radio Astronomy Observatory was used to examine four galactic sources in which the A doublet lines of OH have been observed in emission. The sources W10 (Orion), W24 (Sagittarius), W49, and W75 were observed at all four OH frequencies for both linear and circular polarization. Preliminary spatial mappings of the OH emission were made. Observations made 6 months apart were compared for evidence of secular variation. High-resolution absorption spectra of three sources in the Sagittarius complex, obtained with a resolution of 5 kc/s, reveal the presence of narrow ab-

sorption features. It was found that most of the emission features are polarized, that circular polarization is much more prevalent than linear polarization, and that in many spectra the total amounts of left- and right-circular polarization are unequal. It is shown that Zeeman splitting of the OH line cannot explain the polarization characteristics of the spectra. No conclusive evidence for secular variation of the emission features was found. No polarization was found in the absorption spectra. The intensity ratios of the narrowest absorption features are discussed. To investigate the possibility that relatively large magnetic fields (of the order 10^{-3} gauss) might exist in or near H II regions, the 21-cm line of neutral hydrogen in the direction of the Orion Nebula was studied with the Harvard University 60 foot antenna. An upper limit of $\sim 3 \times 10^{-5}$ gauss was found for a large-scale ordered field in Orion. The possibility of small interstellar regions of high magnetic field cannot be ruled out by this independent measurement. (auth)

31131 COSMIC X-RAY SOURCES. **Tucker, Wallace (Univ. of California, San Diego). Astrophys. J., 148: 745-65(June 1967).**

The line emission from Scorpius XR-1 in the 1- to 10-keV range is computed on the assumption that it is a hot, low-density plasma with a temperature of 5×10^7 °K. Since the intensity of the line emission from an ion is proportional to the relative abundance of the ion, observations in this range should yield information concerning the abundances of the elements in an x-ray source. Also, they would provide a means for distinguishing between radiation from a hot gas and synchrotron radiation. Theoretical estimates of the x-ray emission to be expected from various objects are presented, and it is concluded, among other things, that the x-ray emission from a nova should be observable if it occurs within a distance of 1 kpc. A large flare from αC Ma might also be detectable at x-ray energies. The synchrotron hypothesis for the x-ray emission from the Crab Nebula is examined by considering the time variations in the electron spectrum due to synchrotron losses, expansion, Fermi acceleration, and injection of electrons into the source. A number of models are constructed which are consistent with the radio, optical, and x-ray observations. (auth)

31132 ON THE NATURE OF FAINT BLUE OBJECTS IN HIGH GALACTIC LATITUDES. I. PHOTOMETRY, PROPER MOTIONS, AND SPECTRA IN PHL FIELD 1:36 + 6° AND RICHTER FIELD M3, II. **Sandage, Allan (Carnegie Inst. of Washington, D. C. California Inst. of Tech., Pasadena); Luyten, Willem J. Astrophys. J., 148: 767-79(June 1967).**

Astrometric, photometric, and spectrographic data are given for a representative sample of objects in a single field of 40 sq deg of the PHL catalogue. F and G subdwarfs, white dwarfs, and "radio quiet" quasi-stellar galaxies (QSG) are the most frequent types of objects, although a few horizontal branch stars, U Gem variables, and RR Lyrae stars are also present. Ten positive QSG identifications have been made from spectra of candidate objects in a list compiled from the bluest objects of small proper motion. The redshifts, $\Delta\lambda/\lambda_0$, of PHL 1127, 1194, and 3424 are 1.990, 0.298, and 1.847, respectively. Spectra of PHL 1027, 1070, 1072, 1186, 1222, 1226, and 3375 prove these to be definite QSG also, but with undetermined redshifts. PHL 1092 is a possible QSG. A firm lower limit for the surface density of QSG in this field is S = 0.25 QSG/sq deg to B = 18 mag, based on ten QSG in 40 sq deg, but the true density is undoubtedly larger, since not all objects in the field have been spectrographically sampled. An upper limit is S = 0.5 QSG/sq deg to B = 18 mag. A small photometric sample of the Richter–Sahakjan list gives S between 1 QSG/sq deg and 3 QSG/sq deg to an optical limit of 19.7 mag. These values far exceed S = 0.004 QSS/sq deg for radio quasi-stellar sources in the 3C R catalogue. It is shown that very strong observational selection operates against finding QSGs of small absolute radio power when optical identifications are made from existing radio catalogues. The number of QSGs may exceed 100,000 over the entire sky to an optical limit of B = 19.7 mag. (auth)

31133 RADIAL VELOCITIES AND SPECTRAL TYPES OF SOME BRIGHT BLUE STARS IN THE OLD OPEN CLUSTER M67. **Pesch, Peter (Case Inst. of Tech., Cleveland). Astrophys. J., 148: 781-6(June 1967).**

Slit spectra at a dispersion of 128 Å mm were obtained of eight stars in M67 which, in the color–magnitude diagram, lie either in the Hertzsprung gap or near the main sequence but above the turnoff point of the majority of the cluster members. Radial-velocity measures based on these spectrograms show that the brightest star in the Hertzsprung gap is most probably not a cluster member and, in addition, give no evidence that any of the stars are short-period, large-amplitude spectroscopic binaries, although duplicity is not disproved. Spectral types of seven of the stars are compatible with cluster membership; two of them are Am stars, the others appear normal. (auth)

31134 A COMPARISON OF BL HERCULIS WITH THE RR LYRAE STARS DURING RISING LIGHT. **Preston, George W. (Univ. of California, Santa Cruz); Kilston, Steven D. Astrophys. J., 148: 787-91(June 1967).**

Simultaneous single-trail spectroscopic and UBV photometric observations are used to show that during rising light BL Her resembles the RR Lyrae type a variables with respect to the size of the U–B excess, the strength of the H emission, and the relative phases of the U–B excess and peak H emission. BL Her differs from the RR Lyrae type a variables with regard to the size of the phase lag of the luminosity curve relative to the velocity curve. A brief comparison is made between the behavior of BL Her and certain predictions of Christy's pulsation calculations. (auth)

31135 ROTATING EMISSION RING IN BINARY SYSTEMS. **Huang, Su-shu (Northwestern Univ., Evanston, Ill.). Astrophys. J., 148: 793-802(June 1967).**

The periodic orbits around the more massive component in the restricted three-body problem were taken as representing quantitatively the rotating gaseous rings discovered through their emission lines in many eclipsing binaries. The periodic orbits were obtained first through a series expansion and further improved by the successive approximation. Thus a theoretical relation, in a tabulated form, was obtained between the velocity of the emission ring and its distance from the more massive component for each of six values of the mass ratio of the two component stars. By using this theoretical relation, the masses of two components in the binary system may be determined by observing the emission ring during eclipse. As an illustration the masses of the two components of RY Gem were found. Applying the same idea of the periodic orbits, the nature of non-synchronous rotation in U Cep and RZ Sct was also examined. (auth)

31136 INSTABILITIES IN HIGHLY EVOLVED STELLAR MODELS. **Rakavy, G.; Shaviv, G. (California Inst. of Tech., Pasadena). Astrophys. J., 148: 803-16(June 1967).**

The structure of heavy stars at highly evolved stages of evolution is considered. It was found that radiation relativistic effects on the electrons and pair creation induce a dynamical instability in stars heavier than about 30 $M_\odot$. The evolution of a 30 $M_\odot$ oxygen star is described in some detail up to the point where it becomes dynamically unstable. (auth)

31137 EARLY EVOLUTION OF FIVE STARS OF MEDIUM MASS. **Hallgren, E. L. (Univ. of Toronto). Astrophys. J., 148: 817-24(June 1967).**

Evolutionary tracks of five stars in the mass range 1.0 to 2.5 $M_\odot$ are computed. The initial composition is X = 0.67 and Z = 0.03. The evolution of these stars is followed through the core hydrogen-burning, hydrogen-exhaustion, thick shell-burning, and shell-narrowing stages. The 1.0 $M_\odot$ star shows the characteristic evolution of a low-mass star, while the evolution of the 2.5-$M_\odot$ star is characteristic of a high-mass star. (auth)

31138 DISTINCTION BETWEEN MICRO- AND MACRO-TURBULENCE IN THE SOLAR PHOTOSPHERE USING LINE PROFILES. **Elste, Guenther H. E. (Univ. of Michigan, Ann Arbor). Contract N(onr)-1224(19). Astrophys. J., 148: 857-63(June 1967).**

On the basis of line-profile studies of sixty-two weak and medium-strong lines of Fe I, whose excitation potentials lie above 3 eV, a distinction between macro- and microturbulence is sought by comparing the observed relation between the half-widths and the equivalent widths with model computations. The shape of the lines near their cores as well as the curves of growth supports the result that the microturbulence velocity must be as low as 1 km/sec, while macroturbulent velocities of at least 1.5 km/sec are needed to explain the observations. These conclusions are drawn from spectra of the center of the disk only. The more extensive study of the velocity field using the complete center-to-limb variation of the line profiles is in progress. (auth)

31139 POSITIONAL CORRELATIONS OF NEARBY STARS. **Miller, R. H. (Univ. of Chicago). Contract AT(11-1)-614. Astrophys. J., 148: 865-76(June 1967).**

A search was made for configuration–space pairings of stars based on a catalogue of nearby stars. To a good approximation, the (spatial) pair distribution function appears to be represented by the product of one-particle distribution functions. Five to ten close pairs seem to remain that do not easily fit into other categories. They have similar space motions; it is tentatively suggested that they indicate dynamical pairing effects. The distribution of adiabatic invariants of the stars was also studied with no pattern emerging. Stars were not segregated according to astrophysical properties for these investigations. (auth)

31140 MOTION OF SHOCKS THROUGH THE SOLAR CHROMOSPHERE. Wentzel, Donat G.; Solinger, Alan B. (Univ. of Michigan, Ann Arbor). Astrophys. J., 148: 877-84(June 1967).

Whitham's theory for the motion of shocks through inhomogeneous media is applied to the chromosphere where magnetic fields can guide shocks. The effects of both the changing ambient gas pressure and the guidance by arbitrarily shaped magnetic fields can be evaluated analytically in case both the medium and the shock are isothermal. In general, the strength of an isothermal shock increases much less with decreasing ambient pressure than does the strength of an adiabatic shock. Parker's suggestion for the origin of spicules is evaluated in some detail. The shocked gas emerging from the lower chromosphere can be identified with spicules and the necessary guiding magnetic fields are less than about 60 gauss only if the shocks can be guided through the unstable regime where $v_{sound} < v_{Alfvén} < v_{shock}$. In this case, the spicules are strongly correlated with magnetic field strength but are nearly independent of the magnitude of photospheric velocities. The theory is also applied to a sudden, flare-caused coronal heating over an undisturbed region of the chromosphere. (auth)

31141 INTERPLANETARY SCINTILLATION IN JOVIAN DECAMETRIC RADIATION. Douglas, James N.; Smith, Harlan J. (Univ. of Texas, Austin). Astrophys. J., 148: 885-903(June 1967).

Spaced-receiver observations over four oppositions establish the origin of the 1-sec component of time structure in Jupiter's decametric emission as diffraction by inhomogeneities in the solar wind moving radially outward from the Sun. Arguments from simple diffraction theory suggest inhomogeneity correlation scale sizes ranging from a few hundred to a few thousand kilometers and set an upper limit on the intrinsic angular size of Jupiter's decametric source at about 5″. (auth)

31142 INTERPLANETARY GAS. XIV. ON THE EXTENT OF EFFECTIVE COROTATION. Brandt, John C. (Goddard Space Flight Center, New York). Astrophys. J., 148: 905-10(June 1967).

The super Alfvénic point or distance of effective co-rotation for the loss of angular momentum in the solar wind plasma is found by extrapolating observed plasma densities and velocities, and magnetic fields back toward the Sun. The result is approximately 20 to 40 $R_\odot$ for quiet conditions, and possibly a larger value for disturbed conditions. This value is somewhat larger than the usual estimates made by extrapolating the solar surface field outward. The theoretical treatment of Weber and Davis permits an estimate of the angular momentum carried by the plasma, and these estimates are consistent with the values of the tangential velocity of the solar-wind plasma at Earth inferred by Brandt from studies of Type I comet tails. Such effective co-rotation distances change the interpretation of the Sun–Earth delay times, complicate the search for the solar M regions, and imply an e-folding time for braking of solar rotation comparable to the age of the Sun. (auth)

31143 EXAMINATION OF THE EVIDENCE FOR THE EXISTENCE OF PYGMY STARS. Eggen, Olin J.; Sandage, Allan (Carnegie Inst. of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 148: 911-22(June 1967).

Includes criticism to paper by F. Zivicky and author's reply.

The kinematic, spectroscopic, and photometric data for five blue stars of high proper motion are reviewed. These stars have been suggested to be much fainter than conventional white dwarfs and have been called "pygmy stars," or "blue ultradwarfs" by Zwicky. New photometry shows that the stars are redder than the estimates made at the time of discovery by Luyten and because of the sensitivity of the color-luminosity relation for white dwarfs, this redness removes the kinematic anomaly which originally led to the postulation of this new class of stars. It is believed that there is now no observational evidence—photometric, kinematic, or spectroscopic—for the existence of pygmy stars. Although not pygmies, the stars investigated here are nevertheless quite interesting. Three of the five are high-velocity white dwarfs with kinematic properties similar to subdwarfs and RR Lyrae variables of extreme Population II. The red dwarf LP101-15, which forms a wide common proper-motion pair with the white dwarf LP101-16, was found to be an eclipsing system whose primary component is an M4 dwarf. The period is either $1.^d26796$ or $0.^d63398$, depending on the existence of a secondary eclipse. The present photometry is incomplete on this point. Criticisms by Zwicky are given in a note following the paper and the authors in turn discuss Zwicky's criticisms. (W.D.M.)

31144 RADIAL VELOCITIES IN THE ORION NEBULA. Kaler, James B. (Univ. of Illinois, Urbana). Astrophys. J., 148: 925-6(June 1967).

The confirmation of the existence of the differential expansion of the Orion Nebula has recently been reported (Kaler, 1965). It was hoped that the development of an ionization model of the nebula would result in the derivation of the true velocity gradient. This work is presently in progress, but since it will be some time before completion, the observational results are presented, as well as some present conclusions. (W.D.M.)

31145 ELECTRON TEMPERATURES OF IONIZED NEBULAE DERIVED FROM Hβ AND RADIO FLUX DENSITIES. Ko, H. C. (Ohio State Univ., Columbus). Astrophys. J., 148: 927-9(June 1967).

Electron temperature is one of the fundamental physical parameters for ionized nebulae such as planetary nebulae and H II regions. The accurate determination of the electron temperature is important in understanding various physical processes which take place in these nebula. Estimates of the electron temperature may be made by a number of methods, none of which is completely satisfactory. A method is employed in the present note which makes use of both optical and radio flux measurements. (W.D.M.)

31146 A SEARCH FOR OH-LINE EMISSION FROM GALAXIES. Roberts, Morton S. (National Radio Astronomy Observation, Green Bank, W. Va.). Astrophys. J., 148: 931-3(June 1967).

Eight galaxies of different types were observed in a search for OH-line emission. No signal was detected from any of the systems; upper limits to the antenna temperatures were $T \leq 0.1°K$. The corresponding upper limits for the average projected surface density of OH compared to neutral atomic hydrogen, N_{OH}/N_{HI}, range from $<2 \times 10^{-6}$ to $<7 \times 10^{-5}$. The present observations were aimed primarily at detecting a possible distribution of OH emission similar to that shown by 21-cm hydrogen line emission as well as a search for OH over-abundances in other galaxies. (W.D.M.)

31147 EFFECT OF PROGRESSIVE SOUND WAVES ON THE PROFILES OF STELLAR SPECTRAL LINES. Eriksen, G.; Maltby, P. (Univ. of Oslo). Astrophys. J., 148: 833-43(June 1967).

Progressive sound waves propagating through a region of spectral-line formation in a stellar atmosphere are considered. The sound wave sets the atoms in oscillatory motion. While thus performing an ordered motion, the atoms will emit or absorb radiation if properly excited. The radiation will be absorbed (emitted) at a Doppler-shifted wavelength, the Doppler shift being determined by the velocity given to the radiating atoms by the wave. The sound wave will also alter the density of atoms capable of absorbing or emitting the line in question. The effect (integrated over one period) of progressive sound waves on the shape of spectral lines is calculated in a few simple cases where the line depth is assumed proportional to the line-absorption coefficient. The line profiles are found to be highly symmetrical when the pressure amplitudes of the wave are relatively large. The degree of asymmetry of the line is found to increase with atomic weight of the atoms producing the line. (auth)

31148 FLARES AND THE SUPERPOSITION OF TWO IONOSPHERIC EFFECTS. Nestorov, G. (Geophysical Inst., Sofia); Krivsky, L. Bull. Astron. Inst. Czech., 18: 143-9(1967).

The importance-2 flare of Dec. 12, 1965 was accompanied, in its stage of disintegration, by an arch-shaped flare filament which formed very rapidly and connected regions of two opposite magnetic polarities in the photosphere. A further, 1+ importance flare formed in another active region at the same time. The second flare was characterized by a further, harder emission of impulsive character which caused a range of ionospheric effects on very long, long, and short waves (SEA, SFA SWF, SCNA). These effects are examined. The two x ray emissions during these flare phenomena may also have had a spectral character. The x-ray emission of impulsive character evidently originated from a magnetic bremsstrahlung process during the fast-particle emission from the second flare. Also processed were measurements of solar radio emission in the range of meter and decameter waves. (auth)

31149 A COSMOLOGICAL MODEL FOR OUR UNIVERSE. I. Chiu, Hong-yee (Goddard Space Flight Center, New York. State Univ. of New York, Stony Brook). Ann. Phys. (N.Y.), 43: 1-41(June 2, 1967).

An attempt is made to construct a cosmological model for the Universe, based on currently available astronomical observations and two basic assumptions: (1) Einstein's theory of general relativity is strictly valid without the cosmological constant; (2) the existing laws of physics are strictly valid. Mach's principle is disregarded because its meaning is ambiguous. The present status of knowledge of astronomical observations of the Universe and the cosmological models acceptable under the two assumptions cited above are reviewed. A method of construction of a cosmological model is formulated. Using statistical physics for equilibrium and nonequilibrium processes the course of evolution of the Universe

is reconstructed. From the 3°-K cosmic background radiation, the upper limit of neutral hydrogen density in intergalactic space, and the density of matter due to galaxies, an upper limit for the allowable matter–density of the Universe is obtained. It is found that the bulk part of matter–density in the Universe is in galaxies. The evolution of antimatter in the Universe is calculated and it is found that antimatter must be totally absent from the Universe. Hence there are no antiworlds, antigalaxies, etc. Based on the result a value of 0.02 for the deceleration parameter q_0 was obtained. This is to be compared with the value of 0.5 obtained recently by Sandage. In view of the uncertainties associated with both values, these two values must be regarded to be consistent with each other. Consequently no suggestion of violation of any physical law is made. In conclusion, the Universe can be described by an open cosmological model of the Friedman type. (auth)

31150 GRAVITATIONAL COLLAPSE, NEUTRINOS AND SUPERNOVAE. Schwartz, Robert A. (Brown Univ., Providence). Ann. Phys. (N.Y.), 43: 42-73(June 2, 1967).

The collapse and explosion of a highly evolved stellar core is treated in the framework of general relativistic hydrodynamics. The hydrodynamic equations for spherically symmetric systems, including radiative transfer by neutrinos, are formulated, and numerical methods for their solution are developed. These methods are then applied to the calculation of the dynamics of an unstable model stellar core which has been constructed by Chiu. It is shown that the heating of the imploding material by neutrinos from a hot neutron core is sufficient to reverse the implosion. The subsequent explosion of the envelope is identified with a supernova. (auth)

31151 RECTANGULAR COORDINATES OF BRIGHT GALAXIES ON THE PALOMAR SKY SURVEY CHARTS. King, Ivan R. (Univ. of California, Berkeley); Setteducati, Arthur F. Astrophys. J., Suppl. Ser., 14: 239-62(May 1967).

Rectangular coordinates of the bright galaxies in the de Vaucoulers Reference Catalogue have been calculated that allow quick identifications to be made on the charts of the National Geographic–Palomar Observatory Sky Survey. (auth)

31152 DIFFUSION OF SOLAR PROTONS. Rinehart, Marion C. (Philco-Ford Corp., Palo Alto, Calif.). J. Geophys. Res., 72: 3459-70(July 1, 1967).

To date, two apparently very different data analysis procedures have been successful in organizing a large body of data on energetic solar proton emissions, i.e., those employed by Webber and Krimigis. An attempt is made to demonstrate that the results of these two approaches are quantitatively consistent, lending support to the adoption of a model for the "quiescent" interplanetary medium, which is characterized by an elastic scattering mean free path that varies with time and with distance from the sun. The effects of a radially varying magnetic field superimposed on the scattering medium are then explored through a perturbation treatment of a diffusion equation containing a tensor diffusion coefficient. The tensor coefficient in effect represents a model of the medium, while the small expansion parameter of the perturbation treatment is the square of the ratio of the proton-scattering collision rate to its cyclotron frequency. Within the limits of its applicability, the result of the perturbation treatment exhibits the degree to which the assumed field can distort the interpretation of data based on a field-free (scalar) diffusion model of the interplanetary medium. (auth)

31153 PERIODIC MODEL OF NONSTATIC UNIVERSE. Zaitsev, R. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci., 18: 607-9(1965). (In Russian).

A model of material formations whose critical mass is much greater than 100 $M_\odot$ is examined. The model represents a thin spherical shell with radius R, mass M, and a constant thickness of the wall which contains photon gas with a negligible mass. The wall is assumed to be nontransparent for the photon gas and its thermal heat capacity to be negligible. R is supposed to be much greater than the gravitational radius of M. (W.D.M.)

31154 INSTABILITE GRAVITATIONNELLE ET FORMATION DES ETOILES, DES GALAXIES ET DE LEURS STRUCTURES CARACTERISTIQUES. Communications Presentees au Quatorzieme Colloque International d'Astrophysique, Tenu a Liege, les 20, 21 et 22 Juin 1966. (Gravitational Instability and Formation of Stars, of Galaxies, and Their Characteristic Structures. Communications Presented at the 14th International Conference on Astrophysics, Liege, Belgium, June 20–22, 1966). Mem. Soc. Roy. Sci. Liege (8), 15: 1-369(1967). (CONF-660657).

Separate abstracts were prepared for 40 of the 53 papers and abstracts. (W.D.M.)

For abstracts of individual papers see: 31155–31194.

31155 ORIGIN OF STRUCTURE IN CERTAIN MODELS OF THE UNIVERSE. Harrison, E. R. (Goddard Space Flight Center, Greenbelt, Md.). Mem. Soc. Roy. Sci. Liege (8), 15: 15-28(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

Cosmology is confronted with the problem of explaining how large-scale structures originated in the universe. Within the framework of conventional theory two hypotheses are possible. In the primordial structure hypothesis structural differentiation of a rudimentary form is inlaid within the universe from its earliest moments, whereas in the instability hypothesis structure evolves naturally from small initial disturbances. It is known that according to linearized gravitational theory, small disturbances in an expanding universe grow extremely slowly. This theory is outlined and furthermore it is shown that large structures are unlikely to form as the result of thermal instabilities. Thus, the instability hypothesis is in serious difficulty and it is proposed that one should re-examine the primordial structure hypothesis. One possibility is that differentiation into structural domains is a natural state of matter at very high densities during the earliest stage of expansion of the universe. (auth)

31156 A NOTE ON THE FORMATION OF IRREGULARITIES IN A FRIEDMAN UNIVERSE. Irvine, William M. (Harvard Coll. Observatory, Cambridge, Mass. Smithsonian Astrophysical Observatory, Cambridge, Mass.). Mem. Soc. Roy. Sci. Liege (8), 15: 29-32(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

It is suggested that quantum effects may lead to pronounced inhomogeneities in the early stages of the expansion, and it is pointed out that the magnitude of density fluctuations occurring near the epoch of nuclear density depends very strongly on the state of the universe at nuclear and supernuclear densities. (W.D.M.)

31157 FORMATION OF ASTRONOMICAL SYSTEMS IN AN EXPANDING UNIVERSE. Layzer, David (Harvard Coll. Observatory, Cambridge, Mass.). Mem. Soc. Roy. Sci. Liege (8), 15: 33-8(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

Some aspects of the clustering process are discussed in terms of normal-mode analyses and energy considerations. A statistically homogeneous and isotropic distribution of particles moving at nonrelativistic velocities, together with a uniform radiation field, is considered. (W.D.M.)

31158 ORIGIN OF GALAXIES IN AN OSCILLATING RELATIVISTIC WORLD MODEL. Pachner, J. (Astronomical Inst., Prague). Mem. Soc. Roy. Sci. Liege (8), 15: 45-7(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

An attempt is made to prove that the volume of an oscillating model deduced from the Einstein field equations without any modification and without supposing the existence of a negative pressure never contracts to zero as soon as the matter is not uniformly and isotropically distributed and at the same time its velocity is not distributed according to the Hubble Law. (W.D.M.)

31159 ROLE OF THERMAL INSTABILITY IN GALAXY FORMATION. Rees, M. J. (Cambridge Univ., Eng.). Mem. Soc. Roy. Sci. Liege (8), 15: 51-4(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

Although it is widely believed that galaxies have developed from instabilities in an almost homogeneous primeval medium, attempts to understand this process have met with little success. Gravitational instabilities have a slow growth rate, and would appear to be inadequate unless very large initial density fluctuations are postulated. It is considered whether thermal instabilities are likely to be any more effective. If this indeed proved to be the case, it would have the further advantage of providing a natural explanation for the observed upper limit to the scale of inhomogeneities in the universe. This fact would have no obvious explanation if gravitational instabilities were responsible, whereas there is an upper limit to the size of the regions which could condense as a result of thermal instabilities in an expanding universe. However, it is concluded that thermal instability is unlikely to have played a major part in galaxy formation, whether the universe is correctly described by a steady-state theory or by an evolving cosmological model. The evolving case is discussed briefly, and then some calculations on the development of thermal instabilities in a steady-state universe are summarized. (auth)

31160 DISTRIBUTION OF RED SHIFTS OF RADIO SOURCES AND RICH CLUSTERS. Wilson, A. G. (Douglas Advanced Research Lab., Huntington Beach, Calif.). Mem. Soc. Roy. Sci. Liege (8), 15: 125-8(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

The distribution of optical red shifts of radio sources is shown to be nonuniform, with marked clumping into bands separated by distinct gaps. With the errors of individual red shifts not much larger than the line thickness, these bands and gaps appear to be statistical fluctuations. Although the present total available sample of red shifts is small, the probability of random fluctuations creating this type of nonuniformity is remote. (W.D.M.)

31161 STRUCTURE AND STABILITY OF ROTATING MASSIVE STARS IN GENERAL RELATIVITY. Roxburgh, Ian W. (Univ. of London). Mem. Soc. Roy. Sci. Liege (8), 15: 131-4 (1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

The structure equations for a rotating massive star in the general theory of relativity are presented and solved. The dynamical equations are then considered and the fundamental radial mode of oscillation is calculated from a variational principle. This is found to be zero, implying transition from stability to instability when the radius is 208 times the Schwarzschild radius of the star. This implies that stars less than 2×10^7 $M_\odot$ can reach the temperatures required to burn hydrogen and that more massive stars live for some 1.5×10^4 years before becoming unstable. (auth)

31162 DELAYED EVOLUTION OF STARS IN CLUSTERS. Layzer, David (Harvard Coll. Observatory, Cambridge, Mass.). Mem. Soc. Roy. Sci. Liege (8), 15: 135-6(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

Delayed stellar evolution in protoclusters has recently been studied in some detail by Burke (1965). A model of a protocluster is sketched that shows some promise of avoiding the difficulties brought out by Burke's analysis. (W.D.M.)

31163 INFLUENCE OF ROTATION AND PRESSURE GRADIENTS ON FRAGMENTATION IN COLLAPSING CLOUDS. Arny, T. (Amherst Coll., Mass.). Mem. Soc. Roy. Sci. Liege (8), 15: 147-8(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

Some studies of the gravitational instability of collapsing gas clouds as affected by rotation and pressure gradients are briefly described. Indications are, that while instability is still present, rotation and pressure gradients diminish the growth rates. (W.D.M.)

31164 SOME INSTABILITIES OF NONCIRCULAR MOTIONS IN THE GALAXY. Helfer, H. L. (Univ. of Rochester, N. Y. Sterrewacht, Leiden). Mem. Soc. Roy. Sci. Liege (8), 15: 151-4(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

In certain cases, the evolution of a velocity perturbation of a gas in the galactic disc may be more influenced by the nonlinear terms in the hydrodynamic equations than by the attendant perturbation terms due to the pressure and self-gravitational force. The effect of the nonlinear terms is investigated analytically and it appears as if there will develop spiral arm-like loci characterized by density increases and large values of the derivatives of the velocity perturbation. (auth)

31165 GRAVITATIONAL INSTABILITY IN ISOTHERMAL NEBULAE. Simon, R. (Univ., Liege). Mem. Soc. Roy. Sci. Liege (8), 15: 155-65(1967). (In French).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

Linear and adiabatic ($\gamma = 5/3$), or isothermal ($\gamma = 1$), perturbations in the stratified isothermal nebula in uniform rotation are governed by a 4th-order set of differential equations. This set possesses continuous and discrete spectra in the σ^2, k plane, where k is the wave number and σ the frequency of a typical normal mode of oscillation. The continuous spectra can be derived by the analytical discussion of the singularity of the problem. On the other hand, the discrete spectra can be obtained by numerical integration. Such an integration has been performed for different values of the angular velocity of rotation Ω. It shows that above a certain critical value Ω_c which slightly depends on γ, the rotation completely inhibits the phenomenon of gravitational instability. (auth)

31166 GALACTIC PLASMA: ITS DYNAMICS. Pratap, R. (Univ. Libre, Brussels). Mem. Soc. Roy. Sci. Liege (8), 15: 167-74(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

A general method of applying the kinetic equations to galactic plasma is outlined. The equations of self-consistent fields were applied to a rarefied medium and information regarding the magnetic fields, velocity fields, density distributions was derived. The magnetic field was derived for a particular model instead of feeding in the magnetic field a priori. Detailed calculations regarding further aspects shall be reported elsewhere. (auth)

31167 ENERGY PRINCIPLE FOR GRAVITATIONAL AND MAGNETODYNAMIC STABILITY WITH APPLICATION TO FORCE-FREE FIELDS. Krueger, J. G.; Callebaut, D. K. (Univ., Ghent). Mem. Soc. Roy. Sci. Liege (8), 15: 175-85 (1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

An energy principle is presented (in the frame of the magnetodynamic approximation) which is the unification of the well-known energy principles for gravitational (Chandrasekhar) and magnetodynamic stability (Bernstein et al.). The stability of an infinitely long self-gravitating cylinder of constant density, with a prevalent force-free magnetic field (curl $B = \alpha B$) with α constant, and surrounded by vacuum is investigated. The most general perturbation (including surface deformation) is taken into account. All force-free fields except the Lundquist field are unstable, even with a rigid wall. For the Lundquist field, the necessary and sufficient stability conditions are given. (auth)

31168 UNIFIED THEORY FOR SPIRAL AND RADIO GALAXIES. Greyber, Howard D. (Imperial Coll. of Science and Tech., London). Mem. Soc. Roy. Sci. Liege (8), 15: 189-95 (1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

At the first Dallas Symposium on Relativistic Astrophysics in December, 1963, it was stated, "The creation of spiral structure in galaxies and the evolutionary dynamics of strong radio galaxies and quasars are very similar phenomena on different scales." In this paper more evidence is adduced for this unified theory point of view and a plausible mechanism for generating a galactic dipole magnetic field and its associated gravitationally bound current loop in astrophysical objects are described. In previous papers the relevance of the galactic dipole magnetic field model (GDMFM) to problems of galaxies such as the persistence of spiral structure, the magnetic field configuration in spiral arms and the circulation of interstellar matter has been emphasized. (auth)

31169 MAGNETIC FIELD CONFIGURATION IN GALACTIC SPIRAL ARMS. Greyber, Howard D. (Imperial Coll. of Science and Tech., London). Mem. Soc. Roy. Sci. Liege (8), 15: 197-201(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

Observational and theoretical evidence is adduced for a magnetic field configuration that has the magnetic lines of force running in one direction along the arm above the plane of the galaxy and in the opposite direction below the plane. The model permits the resolution of a basic problem in the theory of star formation. (auth)

31170 EFFECT OF GALACTIC ROTATION ON STABILITY OF A GASEOUS ARM. Graham, R. (Univ. of Liverpool). Mem. Soc. Roy. Sci. Liege (8), 15: 203-5(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

The stability of a gaseous spiral arm is considered and the major factors which affect the stability are listed and briefly discussed. (W.D.M.)

31171 PROPERTIES OF RAPIDLY ROTATING GALAXIES. Vandervoort, Peter O. (Univ. of Chicago). Mem. Soc. Roy. Sci. Liege (8), 15: 209-12(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

The simultaneous solution of the Liouville equation for the structure of a galaxy and the Poisson equation for the galactic gravitational potential is considered for an axisymmetric galaxy in a steady state and for small nonaxisymmetric perturbations of such a galaxy. (W.D.M.)

31172 STELLAR ORBITS AND THE STABILITY OF SPIRAL STRUCTURE. Contopoulos, G. (Univ. of Thessaloniki, Greece). Mem. Soc. Roy. Sci. Liege (8), 15: 213-25(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

The problem of the formation and stability of spiral structure in a disc galaxy composed mainly of stars has drawn much interest in recent years. It is proven that in the case of a spiral field of a rather general form, which rotates as a rigid body, one can find two integrals of motion, corresponding to the Jacobi integral and the "third" integral, which can be used as arguments in the distribution function. If the potential V is given, one can find the density ρ and the distribution function f. If an imposed field δV is applied, over a self-gravitating field V, the time variation of V and the corresponding changes of ρ and f can be found step by step. Some conclusions on the stability of the spiral arms can be derived this way. (W.D.M.)

31173 THE VALIDITY OF THE VLASOV EQUATION FOR A ONE-DIMENSIONAL SELF-GRAVITATING GAS. Lecar, Myron (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass. Inst. for Space Studies, New York). Mem. Soc. Roy. Sci. Liege (8), 15: 227-36 (1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

The magnitude of the two-body relaxation term in the Boltzmann equation for a one-dimensional self-gravitating gas was estimated from numerical experiments. Systems containing N = 50, 100 bodies were integrated for N dynamical periods. There was no secular increase in the entropy, and only a slight tendency toward a central concentration of the more massive particles, supporting the theoretical prediction that the two-body relaxation time is approximately N dynamical periods. (auth)

31174 EVOLUTION OF DENSE STAR SYSTEMS. Gold, T. (Cornell Univ., Ithaca, N. Y.). Mem. Soc. Roy. Sci. Liege (8), 15: 239-41(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

Dense elliptical galaxies of high mass are common, while gaseous systems such as spiral galaxies are rare among radio galaxies. The phenomena that must have taken place in such galaxies that have turned them into radio emitters are likely therefore to be related to high star density and not to high gas density. Dense star systems and a model for radio emission are discussed briefly. (W.D.M.)

31175 INITIAL COLLAPSE AND DYNAMICAL MIXING OF A SPHERICAL CLUSTER. Henon, M. (Institut d'Astrophysique, Paris). Mem. Soc. Roy. Sci. Liege (8), 15: 243-8(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

It is assumed, in general, that a star cluster is formed from a gas cloud; at a given time, for some reason, the cloud fragments into stars. The problem studied in this paper is not how the stars are formed, but what happens just after the stars are formed. (W.D.M.)

31176 STABILITY OF STELLAR SYSTEMS WITH DIFFERENT VELOCITY DISTRIBUTIONS. Graham, R. (Univ. of Liverpool). Mem. Soc. Roy. Sci. Liege (8), 15: 249-52(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

This paper is divided into two parts, both of which deal with the stability of uniform sheets of stars with different velocity distributions. The first part treats a simple nonlinear wave in a stellar sheet. The second part deals with the local stability of a rotating sheet, as first treated by Toomre, and leads to a conjecture concerning the evolution of the stellar velocity distribution in the galaxy. (W.D.M.)

31177 EFFECT OF FAVORABLE ORIENTATION OF GALAXIES IN THEIR CLUSTERS, ITS POSSIBLE ORIGIN AND PROSPECTS. Idlis, G.; Gainullina, R. (Astrophysical Inst., Alma-Ata, USSR). Mem. Soc. Roy. Sci. Liege (8), 15: 255-7 (1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

The effect of favorable orientation of galaxies in their clusters permits distinguishing edge-on galaxies and checking on the correction of transformation of visible density distribution into the real one for accidentally orientated galaxies of different types. Until now, such transformation could be carried out sufficiently only for the most flattened ellipticals of type E-7. (W.D.M.)

31178 PROPERTIES OF THE INTERSTELLAR MEDIUM. McNally, D. (London Univ.). Mem. Soc. Roy. Sci. Liege (8), 15: 279-81(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

The properties of the interstellar gas are outlined insofar as these are known. Some problems connected with these properties are discussed. (auth)

31179 OBSERVATIONAL RESULTS IN CONNECTION WITH THE PROPERTIES OF THE INTERSTELLAR MEDIUM. Nandy, K. (Royal Observatory, Edinburgh). Mem. Soc. Roy. Sci. Liege (8), 15: 283-4(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

Recent extinction observations have shown the nonuniformity of the interstellar extinction law, but it is not certain whether the variation is due to the different orientations or due to different properties and size distributions of the particles from region to region. The wavelength dependence of extinction was investigated for three galactic regions in the direction of Cygnus, Cassiopeia, and Perseus and the results are shown graphically. (W.D.M.)

31180 COOLING OF INTERSTELLAR GAS AFTER COLLISIONAL HEATING. Zimmermann, H. (University Observatory, Jena, Ger.). Mem. Soc. Roy. Sci. Liege (8), 15: 285-8(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

In previous work the collision of two interstellar clouds is considered an instantaneous process in which the kinetic energy of the cloud motion is transformed into thermal energy of the cloud material. The density is supposed to be unchanged both during heating and during cooling. These assumptions are only very rough approximations to reality. A more exact discussion is presented of the collision of two interstellar clouds and the following cooling. (W.D.M.)

31181 CONDENSATIONS IN THE ORION NEBULA. Dyson, J. E. (Univ. of Manchester, Eng.). Mem. Soc. Roy. Sci. Liege (8), 15: 291-6(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

For reasonable efficiency of conversion of radiant energy into kinetic energy of mass motion, the radiation must interact with neutral gas. Neutral gas is known to exist in ionized regions. If neutral condensations were present at the time of ionization of the nebula, then neutral condensations in the nebula at present are possible. These condensations, being much denser than the mean density of the neutral gas, resist the ionizing radiation better. The ionizing radiation incident on a condensation is attenuated by recombined atoms flowing off the condensation surface. (W.D.M.)

31182 FORMATION OF LITHIUM IN YOUNG STARS. Audouze, J.; Gradsztajn, E.; Reeves, H. (Institut d'Astrophysique, Paris. Institut de Physique Nucleaire, Orsay, France). Mem. Soc. Roy. Sci. Liege (8), 15: 299-300(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

Comparatively large abundances of lithium have been observed in T Tauri stars. It is generally believed today that T Tauri stars are very young, that their surface is very active, and that the lithium observed is probably due to spallation reactions induced by high-energy protons on the heavier atoms of the stellar surface. It is pointed out that such a process involves the participation of enormous amounts of energies stored in the form of high-energy particles. Two factors are important in this respect: the targets are rare and the protons are continuously decelerated by electronic collisions. (W.D.M.)

31183 NUMERICAL METHODS IN GRAVITATIONAL COLLAPSE PROBLEMS. McNally, D. (London Univ.). Mem. Soc. Roy. Sci. Liege (8), 15: 301-3(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

The methods of numerical solution of the equation of hydrodynamics with gravitation and the results of such solution for model interstellar gas clouds are briefly discussed. (auth)

31184 NUMERICAL STUDIES RELATING TO STAR FORMATION. Hunter, James H. Jr. (Yale Univ., New Haven). Mem. Soc. Roy. Sci. Liege (8), 15: 307-13(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

Results are presented for preliminary experiments with an improved numerical code for integrating spherically symmetric gas dynamical problems that is essentially free from objections previously encountered. For these preliminary calculations it was decided to study the nonlinear Jeans problem. A uniform,

optically thin medium, in which the heat gains are balanced by the atomic and molecular cooling, was adopted for the undisturbed model. (W.D.M.)

31185 ON THE NATURE OF THE NEUGEBAUER–MARTZ–LEIGHTON OBJECTS. Penston, M. V. (Royal Greenwich Observatory, Herstmonceux Castle, Eng.). Mem. Soc. Roy. Sci. Liege (8), 15: 317-18(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

Neugebauer, Martz, and Leighton have observed ~10 very red objects (I−K = 7.5) in their infrared sky survey. The objects in the range $0^m < K < 3^m$ are concentrated towards the plane of the galaxy. The characteristics of these objects are briefly discussed and a model is proposed. (W.D.M.)

31186 JEANS'S CRITERION AND THE DIMENSIONS OF STARS AND GALAXIES. Callebaut, D. K. (Univ., Ghent). Mem. Soc. Roy. Sci. Liege (8), 15: 319-24(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

It is shown that Jeans's criterion determines a relation between the stellar mass and β, the ratio of gas pressure to total pressure. For β_c this yields an upper limit for the stellar mass, supplementing Chandrasekhar's lower limit and thus strengthening his relation expressing the average stellar mass as a function of the fundamental constants. Moreover, the ratio of the average stellar mass to the proton mass may be expressed by the ratio of the Coulomb potential to the gravitational potential of two protons. The same idea is applied to galaxies and yields a fair estimate for their masses. The interpretation is free from the objection that gravitational instability may be too slow to form a galaxy out of a uniform and infinite medium. (auth)

31187 STABILITY OF A COLLAPSING GAS CLOUD AGAINST FRAGMENTATION. Layzer, David (Harvard Coll. Observatory, Cambridge, Mass.). Mem. Soc. Roy. Sci. Liege (8), 15: 325-8(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

A collapsing spherical cloud of uniform mean density is unstable against the growth of local density fluctuations. The initial development of density and velocity fluctuations is described by first-order perturbation theory. The subsequent development is dominated by nonlinear effects and is accordingly not amenable to rigorous theoretical analysis. A number of semi-quantitative arguments are available, however, bearing on particular aspects of the problem. These arguments are mutually consistent and point to the conclusion that the growth of local fluctuations gives rise to turbulence. Thus the assumption that the growth of local density fluctuations causes an initial separation of the cloud into distinct fragments leads to the conclusion that this condition is highly transitory: the fragments would either be reabsorbed into the cloud or would disintegrate. If the alternative assumption is made that the growth of local density fluctuations gives rise to turbulence, it is found that the tendency of overdense eddies to contract faster than the cloud as a whole is not strong enough to affect their transitory character. (auth)

31188 FRAGMENTATION AND ANGULAR MOMENTUM: ARE THEY REAL PROBLEMS IN THEORIES OF STAR FORMATION? McNally, D. (London Univ.). Mem. Soc. Roy. Sci. Liege (8), 15: 329-30(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20-22, 1966. See CONF-660657.

It is proposed that difficulties encountered over fragmentation and excess angular momentum in theories of star formation is a result of simplifying assumptions rather than the physics of the situation. (auth)

31189 GRAVITATIONAL COLLAPSE IN THE PRESENCE OF A MAGNETIC FIELD. Strittmatter, P. (Univ. of California, San Diego, La Jolla). Mem. Soc. Roy. Sci. Liege (8), 15: 339-41 (1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

Considerable progress has been made in the study of gravitational collapse of hot gas clouds, i.e., clouds in which pressure and gravitational forces are comparable. The same cannot be said of the case in which magnetic field (or rotation) are present (a) because such forces are anisotropic, hence precluding the spherical approximation, and (b) because of the difficulty in dealing with the magnetic configuration outside the cloud. As an initial attempt to treat this problem, the case of a "cold" cloud which is permeated by a "frozen-in" magnetic field is discussed. (W.D.M.)

31190 EFFECT OF ROTATION AND MAGNETIC FIELDS ON THE FORMATION OF SINGLE AND MULTIPLE STARS. Roxburgh, Ian W. (London Univ.). Mem. Soc. Roy. Sci. Liege (8), 15: 343-50(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

The pre-main sequence contraction of spherical stars is briefly discussed. This stage of evolution is then re-examined including the effect of rotation and it is shown that during the growth of a radiative core the angular velocity increases in the central regions of a star until the star becomes unstable. Assuming that the star then splits to form a binary system, it is shown that the predicted properties of close binaries is in good agreement with the observed properties. If the star has a magnetic field which survives the Hayashi phase, then it is shown that this will prevent the formation of binary stars provided the field is greater than 1 gauss. (auth)

31191 EVOLUTION OF SMALL STELLAR SYSTEMS AND THE FORMATION OF DOUBLE STARS. van Albada, T. S. (Kapteyn Lab., Groningen, Netherlands). Mem. Soc. Roy. Sci. Liege (8), 15: 361-4(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

The dynamical evolution of a small group of stars, immediately after their condensation from a collapsed cloud, is considered. It is assumed that the change from the gas-dynamical phase to the phase of interacting point masses occurs quickly and that, hence, the newborn stars find themselves in a situation where they have to obey the laws of Newtonian interaction, while their velocity and density distributions are not yet adjusted to this situation. The group will start to evolve in the direction of a quasi-stationary state. If the total original energy is negative some members will be ejected, leaving a more tightly bound subgroup behind. It has been suggested that this pattern of evolution may bear some relation to the expansion of associations and the formation of double stars. This matter is investigated in a quantitative way through numerical calculations of the N-body problem, starting with more or less random initial conditions. (W.D.M.)

31192 FORMATION OF CLOSE BINARY SYSTEMS. Mestel, L. (Cambridge Univ., Eng.). Mem. Soc. Roy. Sci. Liege (8), 15: 351-8(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

The formation of close binary systems is discussed in terms of the theory of magnetic braking of a single star, the coupling between orbital motion and spin, and the time for the system to contract. (W.D.M.)

31193 FEW-BODY PROBLEM AND YOUNG STELLAR SYSTEMS. Worrall, G. (Cambridge Univ., Eng.). Mem. Soc. Roy. Sci. Liege (8), 15: 365-6(1967).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

The question of whether it is likely that the dynamical instability in multiple systems will be resolved by actual ejection of a star or stars is considered. This question was investigated by numerical integration of the equations of motion for such systems. The results are briefly summarized. (W.D.M.)

31194 GRAVITATIONAL INSTABILITY IN INTERSTELLAR MATTER AND STAR FORMATION. Schatzman, E. (Institut d'Astrophysique, Paris). Mem. Soc. Roy. Sci. Liege (8), 15: 265-77(1967). (In French).

From 14th International Astrophysical Symposium, Liege, Belgium, June 20–22, 1966. See CONF-660657.

Theories are proposed to fill in the gaps in observation of the different stages for formation of stars in the galaxy. The point of departure for this analysis is the study of conditions prevailing in the Galaxy, essentially in the solar environment. The physical magnitude of the galactic media, energy and mass balances, gravitational instability and cloud formation, a statistical model, collapse and fragmentation, formation of protostars, and the optically thick protostar are considered. (J.F.P.)

Atomic and Molecular Physics

Refer also to abstracts 31732 and 31827.

31195 (AD-640634) RETROFUGAL FLUX OF ELECTRONS FROM A MONOENERGETIC BEAM DIRECTED AT A THICK TARGET. Final Report, December 1, 1964–January 31, 1966. Dressel, Ralph (New Mexico State Univ., University Park). Sept. 1966. Contract DA-ARO(D)-31-124-G626. 4p. (AROD-4678:3). CFSTI.

A brief survey is given of studies involving the measurement of the magnitude, the angular distribution, and the energy spectra of those electrons returning from a plane interface irradiated by a colimated beam of monoenergetic electrons. (TAB)

31196 (AD-644625) CALCULATION OF THE RATE OF ENERGY LOSS OF SLOW ELECTRONS BY MEANS OF THE EIGENVALUES OF THE BOLTZMANN OPERATOR. Research Report. Gioumousis, George (Lockheed Missiles and Space Co., Palo Alto, Calif. Lockheed Palo Alto Research Lab.). Nov. 1966. Contract Nonr-3368(00). 19p. (LMSC-2-12-66-5). CFSTI.

A new method of calculating the slowing-down time of electrons, based on the eigenvalue problem for the Boltzmann collision operator, is developed. The method is formulated for an isotropic electron distribution in a diatomic gas and an initial electron energy below the vibrational threshold. (auth)

31197 (CONF-661016, pp 325-31) ENGINEERING PROBLEMS IN PRODUCTION AND USE OF INTENSE dc ION BEAMS. Davis, R. C.; Hall, R. R.; Kelley, G. G.; Morgan, O. B.; Stratton, R. F. (Oak Ridge National Lab., Tenn.).

Intense dc ion beams (100 mA–1 A) are being used in the energy range of 15 to 600 keV. The successful production, and use, of the beams have required the solution of many engineering problems and the application of new ideas and materials. The ion sources are especially designed so they can dissipate the intense heat necessary for the production of some beams. Because of space charge problems the accelerator columns are very short and are submerged in the stray field of a magnetic lens. For accessibility these high gradient insulating columns are operated in air and have required the use of epoxy "skirts" to extend the external breakdown path for 600 kV. The stray magnetic fields in the columns have created regions where there are Phillips-Ion-Gage-type discharges. A redesign of a 100 kV column, which can easily be accomplished by using an epoxy insulator, has completely eliminated this problem. Further epoxy tests indicate that the construction of a 600 kV column free of "PIG" discharges is probably possible. (auth)

31198 (JINR-P4-3299) O VOZMOZHNOM VLIYANII SLABOGO VZAIMODEISTVIYA NA STRUKTURU MOLEKULYARNYKH UROVNEI. (On a Possible Effect of Weak Interaction on the Molecular Level Structure). Onishchuk, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1967. 9p. (In Russian). Dep.

The estimates of the value of mixing of Λ-dipole levels of diatomic molecules are given for the case when there exists a weak interaction, which does not preserve the parity, through neutral current as well as when the electrons and nucleons have electric dipole moments. (auth)

31199 (UCRL-17391) PROGRAM BRAGG: A FORTRAN-IV PROGRAM FOR CALCULATING BRAGG CURVES AND FLUX DISTRIBUTIONS. Litton, Gerald M. (California Univ., Berkeley. Lawrence Radiation Lab.). Feb. 24, 1967. Contract W-7405-eng-48. 68p. Dep. CFSTI.

The BRAGG code was used to calculate Bragg curves and number–distance curves for a beam of ions of arbitrary atomic number, atomic weight, and energy, incident on an absorber. The absorber was assumed to be homogeneous, but could consist of an arbitrary number of components, each specified by atomic number, atomic weight, and atomic density. The geometry considered was a broad, well-collimated beam incident on a slab whose transverse dimensions were large compared to the distance travelled by the ions in the absorber. The calculation took into account ionization energy loss, energy straggling, nuclear attenuation, and multiple scattering; but energy deposition from secondary particles was neglected. (M.O.W.)

31200 (N-67-15841) CHEMICAL EQUILIBRIUM OF MULTITEMPERATURE SYSTEMS. Potapov, A. V. Translated from Teplofiz. Vysok. Temp., 4: No. 1, 55-8(1966). 12p. (NASA-TT-F-10495). CFSTI.

A derivation is given of the law of mass action for a multitemperature system. A formula is derived for calculating equilibrium ionization when the electron temperature differs from the heavy-particle temperature. (auth)

31201 NEW METHOD PROPOSED TO INCREASE POLARIZATION IN POLARIZED ION SOURCES OF H^- AND D^-. Sona, P. G. (CISE, Milan. Univ., Milan). Energ. Nucl. (Milan), 14: 295-9(May 1967).

A new method is proposed to enhance polarization in the polarized ion source of "metastable" type. The method uses only static fields, and applies both to protons and deuterons. (auth)

31202 DIELECTRIC CONSTANT OF THE HIGH-DENSITY CHARGED BOSE GAS AND THE VALIDITY OF THE BOHM–PINES ASSUMPTION. Bhatia, M. S. (Univ. of Windsor, Ont.). Can. J. Phys., 45: 2223-6(June 1967).

An expression is obtained for the static dielectric constant of the charged Bose gas in the high-density limit. An explicit and independent demonstration of the validity of the Bohm–Pines assumption is presented. (M.H.R.)

31203 MEASUREMENT OF THE HYPERFINE STRUCTURE OF OPTICALLY EXCITED STATES OF RADIOACTIVE ISOTOPES. Marrus, Richard; Wang, Edmond; Yellin, Joseph (Univ. of California, Berkeley). Phys. Rev. Lett., 19: 1-3 (July 3, 1967).

An atomic-beam experiment was devised by Perl, Rabi, and Senitzky for studying the excited states of the alkalis by direct magnetic resonance. It was shown by Marrus and McColm that the atomic-beam method could be used to study isotope shifts and the optical Stark effect in radioactive isotopes. A description is given of how the method can be modified to obtain a substantial improvement in resolution. It is felt that this method should be generally applicable to the study of the hfs of optically excited states in any isotope that can be deflected in an atomic-beam apparatus. A demonstration is reported of the measurement of the hfs in the $6^2P_{\frac{1}{2}}$ state of ^{134m}Cs. (J.H.M.)

31204 MULTIPLE IONIZATION OF THE RARE GASES BY SUCCESSIVE ELECTRON IMPACTS (0 TO 250 eV). I. APPEARANCE POTENTIALS AND METASTABLE ION FORMATION. Redhead, P. A. (National Research Council, Ottawa). Can. J. Phys., 45: 1791-1812(May 1967). (NRC-9468).

Multiple ionization of the rare gases was examined in a mass spectrometer with a trapped-ion source. Ions with charge multiplicity up to n = 2 (He), n = 5 (Ne), n = 6 (Ar), n = 7 (Kr), and n = 10 (Xe) were observed with electron energies less than 250 eV. For He and Ne the thresholds agree with spectroscopic values of the ionization potentials, indicating a process of the form eN/ee (N + 1), where N represents an ion of charge multiplicity n. For Ar, Kr, and Xe, processes involving metastable states of the ion are also observed, eN/eN^m; $eN^m/ee(N+1)$. The estimated energies of the metastable levels of Ar^+, Kr^+, Xe^+, Ar^{2+}, and Xe^{2+} are in agreement with spectroscopic values. The energies of the metastable states of Ar^+, Kr^+, and Xe^+ are in agreement with measurements of Auger electron emission from metals by metastable ions. The metastable levels estimated for the more highly charged ions (up to n = 5 for Ar, n = 6 for Kr, and n = 8 for Xe) have not been observed previously. The excitation functions of the metastable levels of Ar^+, Kr^+, and Xe^+ are very similar and show a very sharp maximum near threshold. (auth)

31205 ENERGY LEVELS IN THE STATISTICAL ATOM WITH EXCHANGE AND CORRELATION. Jain, Ashok; Kumar, Satish (Univ. of Delhi). Can. J. Phys., 45: 1745-54(May 1967).

Quantum numbers are introduced in a statistical model of atoms that includes the correlation and the exchange terms (TFDC model). Two different types of angular momentum assignments have been introduced into the model and, as an application of this, the single-particle energy levels of the argon atom in its ground state have been calculated. A simple relativistic generalization of the present formalism is discussed and is shown to give better agreement with experimental values. Finally, some suggestions for improvement of the present formalism are made. (auth)

31206 LIFETIMES AND g FACTORS OF RARE-GAS RESONANCE STATES. Wilkinson, P. G. (Naval Research Lab., Washington, D. C.). Can. J. Phys., 45: 1709-13(May 1967).

The mean lifetimes, τ, and ratios, $^3\tau/^1\tau$ of rare gas (Xe, Kr, Ar, Ne) resonance levels, as determined experimentally and theoretically, are intercompared. A new relationship was found connecting τ and the Landé g factor, g: $1/\tau = a - bg$. For $^1P_1^0$: a = 1.80, b = 1.26; for $^3P_1^0$: a = 1.40, b = 0.94, in 10^9 sec^{-1} units. Unexplained deviations are revealed for Ne($^3\tau/^1\tau$) and Xe($^1\tau$, $^1P_1^0$). (auth)

31207 HARTREE–FOCK WAVE FUNCTIONS FOR EXCITED STATES. III. DIPOLE TRANSITIONS IN THREE-ELECTRON SYSTEMS. Cohen, Maurice (York Univ., Toronto); Kelly, Paul S. Can. J. Phys., 45: 1661-73(May 1967).

Hartree–Fock wave functions for a number of S, P, and D states of the lithium isolectronic sequence were calculated, using a simplified procedure described in an earlier paper. Transition matrix elements for all permitted dipole transitions between these states were computed using both the dipole length and the dipole velocity formulations. The results are in good agreement with earlier calculations. (auth)

31208 HARTREE–FOCK WAVE FUNCTIONS FOR EXCITED STATES. IV. OSCILLATOR STRENGTHS IN THE HELIUM ISOELECTRONIC SEQUENCE. Cohen, Maurice (York Univ., Toronto); Kelly, Paul S. Can. J. Phys., 45: 2079-90(June 1967).

Orbital wave functions for a number of singlet and triplet S, P,

and D states of the helium sequence through C^{4+} were calculated using an approximation described earlier. The wave functions were employed to calculate the oscillator strengths for all allowed dipole transitions between these states, using both the length and velocity forms of the transition matrix element. These results are in good agreement with the most accurate values available. (auth)

31209 ASYMPTOTIC LARGE-Z ATOMIC OSCILLATOR STRENGTHS. Cohen, M. (York Univ., Toronto). Can. J. Phys., 45: 2009-14(June 1967).

Two-term asymptotic expansions for the oscillator strengths of a number of important lines of the helium and lithium isoelectronic sequences are presented. The leading term in each expansion is exact, while the second term is obtained by a fit to the accurate f values for Ne^{+8} and Ne^{+7} recently published by Wiese, Smith, and Glennon (1966). It is found that these asymptotic expansions also give very accurate f values for many of the lower members of the two sequences. (auth)

31210 COHERENT RADIATION FROM CADMIUM SULFIDE SINGLE CRYSTALS EXCITED BY AN ELECTRON BEAM. Kurbatov, L. N.; Mashchenko, V. E.; Mochalkin, N. N. Opt. Spectros. (USSR) (Engl. Transl.), 22: 232-6(Mar. 1967).

Translated from Opt. Spektrosk., 22: 429-38(Mar. 1967).

Coherent radiation was obtained from single crystals of cadmium sulfide and investigated at 90 and 300°K. The excitation source was a sharply focused beam of ≤75-keV electrons. The spontaneous-emission spectra of crystals of two types showed lines at 4907, 4928, 4994, and 5012 Å, due to radiative decay of excitons A and B with simultaneous emission of one and two longitudinal optical phonons. The line emission was coherent. Information is presented on the spectral composition of the radiation at 300°K, and the nature of the transitions in the generation mode is discussed. (auth)

31211 NOTE ON THE USE OF FLAT COLLECTORS IN SPUTTERING EXPERIMENTS. Bonnijns, E.; Francken, L. (Univ. Libre, Brussels). Phys. Lett., 24A: 764-5(June 19, 1967).

From the knowledge of the apparent ejection angle, deduced from a direct measurement on the flat collector, and from the angular distribution $P(\theta)$ of atoms around the ejection direction it is possible to determine the correct ejection angle of the atoms sputtered from single crystals. (auth)

31212 PERTURBATION CALCULATION OF THE ENERGY OF THE FIRST EXCITED STATE ($2p\sigma$) OF H_2^+. Silbey, Robert (Univ. of Wisconsin, Madison). J. Chem. Phys., 46: 4026-8(May 15, 1967).

The electronic energy of the $2p\sigma$ state of H_2^+ is calculated by perturbation theory to third order using the Guillemin–Zener wavefunction as a zeroth-order function. The results agree quite well with the exact calculations except for small internuclear distances, as expected. (auth)

31213 INVERSION OF LOW-ENERGY EXPERIMENTAL He–He^+ ELASTIC DIFFERENTIAL SCATTERING SECTIONS TO THE $^2\Sigma_g^+$ AND $^2\Sigma_u^+$ POTENTIALS. Olson, R. E.; Mueller, C. R. (Purdue Univ., Lafayette, Ind.). J. Chem. Phys., 46: 3810-17(May 15, 1967).

An iterative technique coupled with the two-state theory has been employed to obtain the He–He^+ ground state and first excited state potentials from the 10- and 15-eV experimental differential cross sections of Aberth and Lorents. This procedure is adaptable for the inversion of relative data. The resulting ungerade potential displays good agreement with the theoretical calculations of Reagen, Browne, and Matsen in the 0.8- to 2.5-Å region, with the depth of the well found to be 2.34 eV from the 15-eV data. The intermediate regions of both potentials show the dominant term of the power law to be approximately r^{-4}. (auth)

31214 VELOCITY DEPENDENCE OF THE COLLISIONAL EXCITATION TRANSFER PROCESSES OF A RESONANT TYPE. Watanabe, Tsutomu (Univ. of Notre Dame, Ind.). J. Chem. Phys., 46: 3741-8(May 15, 1967). (COO-38-500).

The velocity dependence or the temperature dependence of the excitation transfer processes $A^* + A \rightarrow A + A^*$, $A^* + B \rightarrow A + B^+ + e$, were discussed within the limit of the straight-line trajectory and the impact-parameter method. It has been shown that the velocity dependence corresponds directly with the radial part of the interaction in some cases. In the discrete–discrete resonant case, the cross section σ is proportional to $v^{-2/(n-1)}$ and in the discrete–continuum case it is proportional to $v^{-2/(2n-1)}$, where v is the relative incident velocity of the atom and n is the inverse exponent of the radial part of the interaction. (auth)

31215 ANALYSIS OF ELASTIC-SCATTERING DATA IN THE SEMICLASSICAL APPROXIMATION. Greene, E. F. (Brown Univ., Providence); Reck, G. P.; Rosenfeld, J. L. J. J. Chem. Phys., 46: 3693-7(May 15, 1967).

The usefulness and accuracy of several approximations in the semiclassical derivation of the differential elastic scattering cross section are evaluated for the purpose of defining the best way of analyzing experimental data to obtain potential parameters. (auth)

31216 ACCURATE SINGLE-CENTER EXPANSIONS WITH SLATER-TYPE ORBITALS: HYDROGEN ATOM AND HYDROGEN MOLECULAR ION. Hayes, Edward F.; Parr, Robert G. (Johns Hopkins Univ., Baltimore). J. Chem. Phys., 46: 3577-85(May 1, 1967).

Single-center wavefunctions are determined for the off-center hydrogen atom, using Slater orbitals of integral quantum number and variable orbital exponent. With the proton situated a distance R from the expansion point, for R = 0.6, 1.0, 1.4, and 1.8 bohr, the approximate energies obtained are 0.49961, 0.49951, 0.49929, and 0.49913 a.u. A single-center wavefunction is given for the $1s\sigma_g$ state of H_2^+ for the internuclear separation 2.0 bohr. The energy of this function is within 2×10^{-4} a.u. of the exact result. Here the earlier work of Joy and Handler has been extended by including spherical harmonics with l up to 22 and by reducing the number of nonlinear variational parameters through the rule that the high-l orbitals peak at the protons. Wavefunctions also are presented for the $1s\sigma_g$ and $2p\sigma_u$ states for an internuclear separation of 3.6 bohr. For all of the states considered, the Joy–Handler convergence rule that the energy increment for high l is inversely proportional to l^4 is verified, and extrapolations made. For the hydrogen atom, this increment also is found to be proportional to R^3. By calculations of the dipole moment of the hydrogen-atom functions and by detailed examination of the l = 0 component of these functions, it is shown that the lower-l components in single-center wavefunctions are more sensitive to the presence of higher-l components than had earlier been thought. (auth)

31217 POSITRON ANNIHILATION IN THE NORMAL ALIPHATIC HYDROCARBONS. Gray, Peter R.; Sturm, G. P.; Cook, C. F. (Phillips Petroleum Co., Bartlesville, Okla.). J. Chem. Phys., 46: 3487-9(May 1, 1967).

The lifetimes and intensities of triplet positronium have been measured in 15 normal aliphatic hydrocarbons. The lifetime of the triplet state in the deoxygenated samples decreases from 4.63 ± 0.06 nsec for butane, C_4H_{10}, to 3.19 ± 0.06 nsec for octadecane, $C_{18}H_{38}$. The intensities of the triplet positronium components are less variable; butane has the highest intensity, 38.4% ± 0.8%, and tetradecane, $C_{14}H_{30}$, the lowest, 29.6% ± 1.2%. The cross section for triplet-state quenching, $\langle \sigma v \rangle_{Av} = (M/\rho N_0)(\tau_3)^{-1}$, is shown to have a linear dependence on the length of the hydrocarbon chain. Partial cross sections for quenching by the component groups of the hydrocarbons, the methyl and methylene groups, have values of 0.895 and 0.965×10^{-14} cm^3/sec, respectively. Back calculations of $\langle \sigma v \rangle_{Av}$ using partial quenching cross sections lead to an average error of 0.56% in $\langle \sigma v \rangle_{Av}$ for the 15 hydrocarbons. The largest back-calculated error is 1.92% for butane. (auth)

31218 ENERGY-PARTITION PARAMETERS IN RADIATION STUDIES INVOLVING RARE GASES. Klots, Cornelius E. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Chem. Phys., 46: 3468-74(May 1, 1967). (ORNL-P-2732).

Ion yields observed during plutonium alpha irradiation of binary mixtures containing at least one rare gas are reported. An attempt has been made to analyze them in terms of the modes of initial energy deposition. In order to do so, it was necessary to take account of "negative Jesse effects," tentatively ascribed to the quenching of chemi-ionization mechanisms (the so-called Hornbeck–Molnar reactions) occurring in the rare gases. Energy-partition parameters, obtained in this fashion and earlier, are qualitatively justified by semiempirical calculations. (auth)

31219 EVALUATION OF SCATTERING CROSS SECTIONS IN THE OPTICAL MODEL BY THE METHOD OF STATIONARY PHASE. Sun, H. Y.; Ross, J. (Brown Univ., Providence). J. Chem. Phys., 46: 3306-8(May 1, 1967).

The elastic scattering cross section is evaluated by the method of stationary phase for two assumed forms of complex phase shifts. The results are applied to the interpretation of measurements on the scattering of K by $SiCl_4$ to yield a value for the total reaction cross section. (auth)

31220 NONREACTIVE SCATTERING OF K BY HBr AND DBr IN CROSSED MOLECULAR BEAMS. Airey, J. R.; Greene, E. F.; Kodera, K.; Reck, G. P.; Ross, J. (Brown Univ., Providence). J. Chem. Phys., 46: 3287-95(May 1, 1967).

The nonreactive scattering of K by HBr and DBr has been measured in crossed molecular beams as a function of relative kinetic energy and for two configurations of the beams and the detector. The effect of averaging over residual energy distributions in the two beam and detector configurations is studied. It is shown that the density of the cross beam must be kept low because attenuations of 50% of the K beam by the cross beam affect the observed

rainbow cross section appreciably. From the rainbow scattering and a kinematic restriction, the parameters for an assumed exp-6 potential ($\alpha = 12$) are found to be K + HBr: $\epsilon = 0.565$ kcal/mole, $r_m = 4.2$ Å; K + DBr: $\epsilon = 0.564$ kcal/mole, $r_m = 3.9$ Å. Chemical reaction affects the nonreactive scattering at large scattering angles. Probabilities of reaction, threshold energies, and total reaction cross sections are obtained from the nonreactive scattering with a simple model used previously. The total reaction cross sections are: K + HBr: 35.0 ± 9.0 Å^2, K + DBr: 26.0 ± 8.0 Å^2 in the energy range 2.6 to 5.8 kcal/mole. (auth)

31221 NUCLEAR MOTION CORRECTIONS TO THE BINDING ENERGY IN HYDROGEN. AN EFFECTIVE POTENTIAL APPROACH. Grotch, H.; Yennie, D. R. (Cornell Univ., Ithaca, N. Y.). Z. Phys., 202: 425-35(1967).

Most of the calculations of nuclear recoil corrections to the atomic binding in hydrogen have been done using the covariant Bethe–Salpeter equation. An alternative to the Bethe–Salpeter approach in the form of a modified Dirac equation is presented. It contains the usual Hamiltonian for an electron in the field of a static proton, but it also includes the proton's kinetic energy and an interaction term due to transverse photons. The part of the interaction which produces the hyperfine splitting is extracted and treated perturbatively, whereas the remainder of the potential is retained, rearranged, and approximated in such a way as to make the resulting equation soluble. In a simple way, one is able to obtain reduced mass corrections to the fine structure and the hyperfine structure of hydrogen. An extension of the work, which enables calculation of additional recoil terms not included in the lowest order effective potential, is briefly described. (auth)

31222 ALMOST "HEAD-ON" COLLISIONS IN THE SCATTERING OF FAST ARGON ATOMS BY HYDROGEN ISOTOPES. Jordan, J. E. (National Bureau of Standards, Washington, D. C.); Amdur, I. J. Chem. Phys., 46: 4145-6(May 15, 1967).

Elastic scattering cross sections were obtained from the axial attenuation of argon beams, with energies between 400 and 200 eV, by H_2 and D_2 at room temperature. The results showed a substantial decrease in the cross section when H_2 is the scattering gas, rather than D_2. (M.O.W.)

31223 SINGLET–TRIPLET TRANSITIONS IN THE ELECTRON IMPACT SPECTRUM OF N_2. Skerbele, Ausma; Dillon, Michael A.; Lassettre, Edwin N. (Mellon Inst., Pittsburgh). J. Chem. Phys., 46: 4161-2(May 15, 1967).

Singlet–triplet transitions in the electron impact spectrum of N_2 in the range of 35 to 100 eV were studied. (M.O.W.)

31224 CHARGE TRANSFER OF N_2^+ AND O_2^+ WITH SODIUM ATOMS. Henderson, W. R.; Mentall, J. E.; Fite, W. L. (Univ. of Pittsburgh). J. Chem. Phys., 46: 3447-9(May 1, 1967).

Collisions of nitrogen and oxygen molecular ions with atomic sodium have been examined in a crossed-beam experiment in which the ion energy range was from 25 to 200 eV. It was found that charge transfer occurs with cross sections in excess of 10^{-16} cm^2 and that in both cases the energy dependence is that typical of accidental resonance charge transfer. Extrapolation of these cross sections to the thermal energy range suggests that the thermal-energy charge-transfer rates are about 5×10^{-11} cm^3/sec with N_2^+ and about 8×10^{-11} cm^3/sec for O_2^+. (auth)

31225 TOTAL CROSS SECTIONS FOR IONIZATION AND ELECTRON ATTACHMENT IN C_2F_8, C_3F_8, AND C_4F_8. Kurepa, Milan V. (Inst. of Physics, Belgrade). pp 107-15 of Third Czechoslovak Conference on Electronics and Vacuum Physics, Transactions, Held in Prague on September 23rd–28th, 1965. Paty, Libor (ed.). Prague, Publishing House of the Czechoslovak Academy of Sciences, 1967.

See CONF-650987.

Three fluorocarbon gases C_2F_8, C_3F_8, and C_4F_8, were bombarded in an ionization chamber by electrons. The ionization and electron attachment cross sections were measured. (M.O.W.)

31226 INVESTIGATION OF THE INTERACTION OF THE ELECTRON BEAM WITH ALKALINE EARTH OXIDES. Andronov, A. N.; Borisov, V. L.; Ignateva, I. V.; Lepeshinskaya, V. N. (Leningrad Polytechnic Inst.). pp 423-8 of Third Czechoslovak Conference on Electronics and Vacuum Physics, Transactions, Held in Prague on September 23rd–28th, 1965. Paty, Libor (ed.). Prague, Publishing House of the Czechoslovak Academy of Sciences, 1967.

See CONF-650987.

A method was developed and used to study the alkaline earth oxide film decay based on the secondary electron emission factor change during bombardment. The data showed the temperature dependence of the decay processes, and the linear dependence of the decay rate upon the current density may prove the one-stage dissociation process. (M.O.W.)

31227 HYPERFINE STRUCTURE ANOMALIES AND NUCLEAR QUADRUPOLE INTERACTION CONSTANTS OF THE EXCITED $3d^9 4s 4p^4 P_{\frac{5}{2}}$-TERMS IN THE CuI SPECTRUM OF ^{63}Cu AND ^{65}Cu. Bucka, H.; Ney, J.; Wirtnik, K. P. (Technische Univ., Berlin). Z. Phys., 202: 22-31(1967). (In German).

The hyperfine structure of the excited $3d^9 4s 4p^4 P_{\frac{5}{2}}$ term of the CuI spectrum was investigated in a level-crossing experiment using an atomic beam with copper in natural abundance as absorber. From the level-crossing signals the following relations for the hyperfine structure constants were deduced $A(^{63}Cu) = 2184.66(17)(g_J/1.75)$Mc/sec, $B(^{63}Cu) = -38.65(11)(g_J/1.75)$Mc/sec, $A(^{65}Cu) = 2340.15(19)(g_J/1.75)$Mc/sec, $B(^{65}Cu) = -35.69(17)(g_J/1.75)$ Mc/sec. The ratio of the magnetic hyperfine structure constants of ^{63}Cu and ^{65}Cu was determined with high accuracy to be $[A(^{63}Cu)/A(^{65}Cu)] = 0.93355$ (2). From this ratio a hyperfine structure anomaly $_{63}\Delta_{65}(^4P_{\frac{5}{2}}) = 1.4 \cdot 10^{-4}$ (4) was deduced. The width of the zero field crossing yielded a lifetime $\tau = 3.2$ (3) $\cdot 10^{-7}$ sec for the excited $^4P_{\frac{5}{2}}$-term. (auth)

31228 HARTREE–FOCK TOTAL ENERGY DIFFERENCES IN THE MG I ISO-ELECTRONIC SEQUENCE. Wilson, M. (Argonne National Lab., Ill.). Astrophys. J., 148: 937-8(June 1967).

Using a program developed by Froese (1966), Hartree–Fock self-consistent field calculations were performed for the configurations $3s^2$, 3s3p, 3s3d, and $3d^2$ for the ions Mg I, Al II, Si III, P IV, Cl VI, K VIII, and Sc X. For ions such as these in the short periods, it was found that the energies of separation between the average energies of configurations are given to within 10% of the experimentally observed values by taking differences in the computed total energies. (W.D.M.)

31229 ABSORPTION OF RADIATION BY UNIFORMLY SPACED DOPPLER LINES. Kyle, T. G. (CSIRO, Victoria, Australia). Astrophys. J., 148: 845-8(June 1967).

It is shown that the absorption coefficient for an infinite array of uniformly spaced Doppler lines, having either uniform or exponentially varying strengths, can be expressed in terms of a theta function. This form of expression is most useful when the line spacing is not too large in comparison to the Doppler width of the lines. In this case the average absorption within the band can be expressed in terms of a Bessel and an exponential function. (auth)

31230 ISOTOPE SHIFTS OF EVEN AND ODD Sm AND Nd ISOTOPES. Hansen, J. E.; Steudel, A.; Walther, H. (Technische Hochschule, Hanover). Z. Phys., 203: 296-329(1967). (In German).

The isotope shift of the natural isotopes of Sm and Nd was investigated by a digital recording Fabry–Perot spectrometer using highly enriched samples. By the accuracy achieved in the measurements it was possible to verify earlier results indicating different relative isotope shifts for lines with positive and negative displacements, and to show that also lines with the same sign of the displacement may have different relative isotope shifts. It is shown that these nonconstant relative isotope shifts can be explained for the even isotopes by the different contributions of the mass and volume effect to the isotope shifts in the different lines, but this explanation seems only to be partly valid for some distances between even and odd isotopes. The size of the mass effect is estimated and its influence especially on the results of the odd–even staggering is considered. The odd–even staggering is compared to earlier results for Hg. The estimation of the mass effect shows that the results for $\delta\langle r^2\rangle$ determined from the measured isotope shifts without correcting for the mass effect may be considerably wrong. Nevertheless, it is possible by a suitable combination of the measured distances to calculate a quantity which only depends on nuclear properties and which therefore enables one to check the known theories of the volume dependent isotope shift also without calculating the probability density of the s electrons at the nucleus. (auth)

31231 NONLINEAR AND SECOND ORDER THERMAL DIFFUSION OF ELECTRONS IN IONIZED GASES. Sharma, S.; Kaw, P. K. (Indian Inst. of Tech., New Delhi). Z. Phys., 203: 330-2(1967).

The nonlinear and second order thermal diffusion of electrons in ionized gases was investigated, using the techniques of the kinetic theory. The temperature dependence of the electron density was taken into account in contrast with earlier workers. (auth)

31232 ENERGY LOSS MEASUREMENTS ON SILVER WITH HIGH ENERGY RESOLUTION. Daniels, J. (Univ., Hamburg). Z. Phys., 203: 235-49(1967). (In German).

In energy loss experiments on Ag films with monochromatic fast electrons the separation of surface and volume loss is demonstrated. The surface loss is found at 3.63 ± 0.02 eV with a half-

width of ≈250 mV. The volume loss at 3.78 ± 0.02 eV has a half-width of 75 ± 15 mV. The energy loss spectrum is compared with that computed from optical data by means of the dielectric theory and shows good agreement. Also the dependence of the surface loss from the scattering angle and the angle of incidence is in agreement with calculated values. The shift of the volume loss with temperature of $-2.5 \cdot 10^{-4}$ eV/degree agrees with values obtained from experiments on plasma radiation. (auth)

31233 ELECTRON-IMPACT IONIZATION CROSS-SECTIONS AND IONIZATION RATE COEFFICIENTS FOR ATOMS AND IONS. Lotz, Wolfgang (Institut fuer Plasmaphysik, Munich). Astrophys. J., Suppl. Ser., 14: 207-38 (May 1967).

All available experimental data on cross sections for single ionization of atoms and ions from the ground state by electron impact in the low-energy range (≤10 keV) were collected. For each species a best-fit curve was drawn. The experimental results can be approximated by the following formulae: $\sigma = \zeta_1\{[a \ln (E/\chi_1)]/[\chi_1 \cdot E]$ [cm^2], if $\chi_1 \le E \le \chi_2$, $\sigma = \Sigma_{i=1}^{N} \zeta_i\{[a \ln (E/\chi_i)]/[\chi \cdot E] = \zeta\{[a \ln (E/\bar{\chi})]/[\bar{\chi} \cdot E]\}$, if $E \ge \chi_N$, where χ_1 is the ionization potential or electrons in the outermost shell in electron volts, χ_2 is the ionization potential for electrons in the next inner (sub) shell, etc., $\bar{\chi}$ is a weighted mean of χ_1 and χ_2, etc., E is the electron energy in electron volts, $a = 4.0 \times 10^{-14}$, $\zeta \ge 0.5$ is a slowly varying function and asymptotically equal to the number of equivalent electrons. In most cases it is sufficient to set N equal to 2, but for Kr and Xe N = 3 gives better results. By comparison of isoelectronic species as well as of equally charged species it is possible to make predictions for yet unknown cross sections. Ionization rate coefficients for all species in the triangle H I–Na I–Na XI are given with an estimated error of $^{+40}_{-30}$ percent. (auth)

31234 LOCAL DENSITY DETERMINATIONS IN RAREFIED GAS FLOWS BY MEASURING THE LARGE-ANGLE SINGLE-SCATTERING FROM AN ELECTRON BEAM. Grodski, Juliusz J.; Schumacher, B. W. (Ontario Research Foundation, Toronto). ISA (Instrum. Soc. Amer.), Trans., 6: 103-10 (Apr. 1967).

The large-angle scattering from a small region of an electron beam passing through a rarefied gas flow can be used to measure the local gas density. Theoretical estimates and experimental determinations of the sensitivity showed that the method is practical in the range from about 0.02 to 2 torr. Extension of the method into a picture-forming system is also discussed. (auth)

31235 AUTOIONIZING D STATES IN He BELOW THE n = 2 LEVEL OF He^+. Cooper, J. W.; Ormonde, S.; Humphrey, C. H.; Burke, P. G. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Phys. Soc. (London), 91: 285-7 (June 1967).

Close-coupling calculations of the positions and widths of the lowest-lying autoionizing D states of He converging on the n = 2 level of He^+ are presented. Good agreement is found with experiment and with other calculations in almost all cases. (auth)

31236 AN EXPERIMENTAL STUDY OF ELECTRON LOSS DURING THE PASSAGE OF FAST HYDROGEN ATOMS THROUGH ATOMIC HYDROGEN. Wittkower, A. B.; Levy, G.; Gilbody, H. D. (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 91: 306-9 (June 1967).

The process of electron loss in single collisions during the passage of fast hydrogen atoms through hydrogen was studied in the energy range 40 to 220 keV. The ratio $Q_{01}(H)/Q_{01}(H_2)$ of the electron-loss cross sections in atomic and molecular hydrogen was determined using a tungsten tube furnace to provide a target composed of highly dissociated hydrogen. At energies above about 120 keV, cross sections $Q_{01}(H)$ estimated by the use of well-established values of $Q_{01}(H_2)$ are found to be in good agreement with theoretical values calculated by Bates and Griffing [Proc. Phys. Soc., A66: 961-71 (1953)] using Born's approximation. (auth)

31237 VIBRATIONAL TRANSITION PROBABILITIES AND r CENTROIDS OF THE A → X BAND SYSTEM OF ZrO. Singh, P. P. D.; Pathak, A. N. (Univ of Gorakhpur, India). Proc. Phys. Soc. (London), 91: 497-8 (June 1967).

A partial ($\nu' + \nu'' \le 8$) array of Franck–Condon factors and r centroids is reported for some bands of the $A^3\phi \rightarrow X^3\Delta$ band system of the zirconium oxide molecule which is of astrophysical interest and which is found in S-type stars. (auth)

31238 FRANCK–CONDON FACTORS AND r CENTROIDS FOR BAND SYSTEMS OF ZrO. Nicholls, R. W.; Tyte, D. C. (York Univ., Toronto). Proc. Phys. Soc. (London), 91: 489-96 (June 1967).

The character of the electronic states and transitions between them of the astrophysically important molecule ZrO are reviewed. Franck–Condon factors and r centroids, calculated on the basis of a Morse model, are displayed, with wavelengths of known bands, for the α, β, γ, A, and B band systems. (auth)

31239 ASYMPTOTIC FORM OF THE FORWARD e^-–H ELASTIC SCATTERING AMPLITUDE. Roberts, M. J. (Univ. of Liverpool). Proc. Phys. Soc. (London), 91: 508-10 (June 1967).

The leading terms in the asymptotic energy expansion of the forward elastic scattering amplitude of electrons incident on the ground state of the hydrogen atom are investigated using the first Born approximation to the cross section, together with a dispersion relation, and compared with the expansion based on the Born series. (auth)

31240 HIGH-RESOLUTION MEASUREMENT OF ELECTRON EXCITATION TO THE 4S STATES OF HELIUM. Heddle, D. W. O.; Keesing, R. G. W. (Univ. of York, Eng.). Proc. Phys. Soc. (London), 91: 510-12 (June 1967).

Using a hemispherical electron monochromator the optical excitation functions of the 4 ^{1}S and 4 ^{3}S states of helium close to threshold were measured. Both excitation functions reach a significant value within 30 mV of threshold and show two narrow maxima. The second maxima coincide in energy (between 23.77 and 23.80 eV) and are identified with a resonance having the configuration $(1s5s^2)^2S_{\frac{1}{2}}$. (auth)

31241 PRELIMINARY REPORT ON THE SECOND SPECTRUM OF PROTACTINIUM (Pa II). Giacchetti, A. (Argonne National Lab., Ill.). J. Opt. Soc. Amer., 57: 728-33 (June 1967).

The first results of a continuing analysis indicate that the ground configuration of the first ion of protactinium is $5f^27s^2$, the ground level being $^3H_4$. 656 lines have been classified as combinations between 25 low-even and 164 high-odd energy levels; these represent approximately 35% of the lines that have been assigned to the second spectrum of protactinium. Four other low-lying levels have been assigned to the $5f^26d7s$ configuration. The importance of the use of hfs measurements in the level-searching program is stressed. (auth)

31242 FREQUENCY DISPLACEMENT OF THE LINES EMITTED BY A COMPLEX ATOM EXPOSED TO A UNIFORM EXTERNAL ELECTRIC FIELD. APPLICATION TO ALUMINUM. Bach, Truong (Observatoire de Paris-Meudon, Hauts-de-Seine, France). Compt. Rend., Ser. A and B, 264: 1011-14 (Apr. 3, 1967). (In French).

The phenomenon of frequency displacement of lines emitted by a complex atom placed in a uniform electric field is studied. The equation describing this displacement is derived and numerically evaluated for aluminum. The calculated results are compared with the experimental results. (J.S.R.)

31243 PROBABILITY OF TRANSITION OF A CRYSTAL ELECTRON IN A STRONGLY BOUND STATE TOWARD AN EXCITED STATE UNDER THE ACTION OF ELECTRON BOMBARDMENT. Cailler, Michel (Laboratoire de Physique du Metal, Nantes, France). Compt. Rend., Ser. A and B, 264: 1029-31 (Apr. 3, 1967). (In French).

The expression for the transition probability of a strongly bound electron in a crystal toward an excited state is established. The expression is applied to the particular case of Li. By comparing the numerical results with those previously obtained it is shown that the participation of the initial bound state is weak and negligible in the transition considered. (tr-auth)

31244 POSSIBILITY OF OBSERVATION OF TWO-PHOTON RESONANCE. Basov, N. G.; Oraevskii, A. N.; Strakhovskii, G. M. (Lebedev Inst. of Physics, Moscow). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 10: 473-6 (1967). (In Russian).

There is shown the possibility to observe the two-photon resonance in the molecular beams in the uhf range. The necessary radiation power for this effect is estimated. (auth)

31245 CYLINDRICAL WAVE INTERACTION WITH RADIALLY DIVERGING ELECTRON BEAM. Savel'ev, V. S. Izv. Vyssh. Ucheb. Zaved., Radiofiz., 10: 575-81 (1967). (In Russian).

From the equations of the radial waveguide excitation by bunched currents and those of electronics, the differential third-order equation with the variable coefficient in a linear approximation was obtained in order to determine the strength of the high-frequency electric field. The solution of the equation has been found by the method of high-frequency field expansion over a small parameter. The law of the field amplitude increase and amplification coefficient were determined, taking into account a spatial charge, the nonsynchronism parameter, and distributed losses. (auth)

31246 STUDY OF THE BEHAVIOR OF MUONIUM IN SCINTILLATING PLASTIC. Myasishcheva, G. G.; Obukhov, Yu. V.; Roganov, V. S.; Firsov, V. G. (Inst. of Theoretical and Experimental Physics, Moscow. Joint Inst. for Nuclear Research, Dubna, USSR). JETP Lett. (USSR) (Engl. Transl.), 5: 182-4 (Apr. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 227-30(Apr. 1, 1967).

The asymmetry coefficients (c') for precession were measured in a transverse magnetic field at a frequency corresponding to the "free" μ^+ meson. It is shown that, within the limits of experimental errors, the quantity c'_{μ} remains constant. The observed difference between the asymmetry coefficients in longitudinal and transverse magnetic fields cannot be attributed to experimental errors and requires a theoretical foundation. (M.H.R.)

31247 RESONANCES IN ATOMIC COLLISIONS. I. ELECTRON–ATOM, ELECTRON–MOLECULE ELASTIC RESONANCE. Barat, Michel; Baudon, Jacques; Bliman, Samuel (Faculte des Sciences, Orsay, France). J. Phys. (Paris), 28: 363-76(Mar.-Apr. 1967). (In French).

The different types of resonances studied in atomic collisions having been defined, a review is made of elastic scattering by electron impact. After a survey on the partial-waves method for scattering by a central potential, then, considering the fundamental problem of the collision of two systems, the different approximations made in order to solve this problem are defined. In the case of the two-states approximations, the elastic scattering theory is developed; it leads to the Fano–Cooper formula which gives the cross-section variation in the neighborhood of the resonance. The experimental devices are described in which either transmitted or elastically scattered electron currents are measured. The main results obtained are reviewed in monatomic or diatomic gases, insisting particularly on the interpretation of the "window" effect observed in helium. (auth)

31248 EXCITATION OF NITROGEN BY α PARTICLES: ABSOLUTE MEASUREMENT OF THE NUMBER OF EXCITED STATES GIVING RISE TO LUMINESCENCE IN THE VISIBLE AND NEAR UV. Tatischeff, I. (Institut du Radium, Paris). J. Phys. (Paris), 28: 297-300(Mar.-Apr. 1967). (In French).

A study of specific fluorescence curves allows one to find a relation between the luminescence measured at the beginning of the path and the luminescence induced by an α particle being completely stopped in a gas. This makes it possible to get an absolute measurement of luminescence, as a function of pressure. An extrapolation at $p = 0$ of $L = f(p)$ allows one to determine the total number of excited states created in the spectral field investigated. (auth)

31249 PHOTOELECTRIC EFFECT AT 279 keV IN LEAD: ANGULAR DISTRIBUTION AND SCATTERING OF K PHOTOELECTRONS. Oms, J.; Chedin, P. (Univ., Grenoble, France. CEN, Grenoble, France). J. Phys. (Paris), 28: 281-7(Mar.-Apr. 1967). (In French).

A short analysis is made of available data on the relativistic K-shell photoeffect and elastic electron–atom scattering. An experimental study of the angular distribution of K photoelectrons ejected from thin (0.92 and 1.39 mg/cm^2) lead layers by 279-keV photons is described and is shown to support Hultberg's scattering correction. The influence of this correction on nuclear spectroscopy measurements by external conversion is studied. (auth)

31250 CONTRIBUTION TO THE THEORY OF RAMAN SCATTERING OF X RAYS. Arinshtein, M. M.; Arinshtein, E. A. (Tomsk Polytechnic Inst., USSR. Tomsk Inst. of Radioelectronics and Electronic Tech., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 2, 44-7(1967). (In Russian).

The scattering of quanta by bound electrons was considered in the nonrelativistic approximation. Whereas in the usual calculation the electron binding energy is assumed small, so that the momentum conservation laws are not violated, it is shown that in the case of x rays the momentum of the quantum itself can be lower than the momentum absorbed by the electron coupling, and this can change the nature of the x-ray scattering. The matrix element of the transition of the electron from the initial to the final state is calculated without the assumption of intermediate states. The resultant equation for the scattering cross section shows that besides the usual scattering, in which the quanta lose practically no energy, scattering can occur in which high-energy electrons and very soft quanta are produced. The cross section of this process is small, but the produced high-energy electrons and soft quanta can produce radiation damage in some substances. (ATD)

31251 TWO-PHOTON EMISSION FROM THE SINGLET METASTABLE STATE OF SINGLY IONIZED LITHIUM. Victor, G. A.; Dalgarno, A. (Queen's Univ., Belfast). Phys. Rev. Lett., 18: 1105-6(June 19, 1967).

Equations are given for the lifetime for two-photon decay and were solved for the 2^1S state of singly ionized Li. The results show a broad distribution of the emitted photons around ~30 eV, and the lifetime against two-photon decay was calculated to be 5.15×10^{-4} sec. (D.L.C.)

31252 SHOCK-TUBE MOLECULAR BEAM FOR O AT 3 eV. Peng, T. C.; Liquornik, D. L. (General Motors Corp., Santa Barbara, Calif.). Rev. Sci. Instrum., 38: 989-91(July 1967).

The production of a short-duration molecular beam from a shock tube source is described. The source gas was in the thermodynamic equilibrium state behind a reflected shock in 94% He and 6% O. The measured beam velocity was within 10% of the theoretical maximum velocity. Calculated results for impact pressure according to a nozzle flow-free jet model were found to agree qualitatively with the experimental data. Based on the measured beam velocity and impact pressures, the beam at 50 cm from the source was estimated for O atoms to have about 3 eV beam energy, 10^{12} p/cc beam density, and 6.34×10^{17} p/cm/sec beam flux. (L.B.S.)

31253 ELECTRON DETACHMENT AND CHARGE TRANSFER IN $H-H^-$ COLLISIONS. Bardsley, J. N. (Univ. of Manchester, Eng.). Proc. Phys. Soc. (London), 91: 300-5(June 1967).

The perturbed stationary-state approximation is used to calculate the cross section for electron detachment and charge transfer in $H-H^-$ collisions. The problem of the absence of bound states of H_2^- is overcome by the introduction of resonant states. For incident energies between 50 and 10,000 eV the electron-detachment cross section decreases monotonically from 18×10^{-16} cm^2 to 6×10^{-16} cm^2, and the charge-transfer cross section decreases from 70×10^{-16} cm^2 to 0.2×10^{-16}. (auth)

31254 PHOTOMULTIPLIER GATE FOR STIMULATED-SPONTANEOUS LIGHT SCATTERING DISCRIMINATION. De Martini, Francesco; Wacks, Kenneth P. (Massachusetts Inst. of Tech., Cambridge). Rev. Sci. Instrum., 38: 866-8(July 1967).

A simple gating method for photomultipliers is presented. The very high cutoff efficiency of the gate, its linearity, and the absence of spurious effect are shown by measurements taken on a RCA 7265 tube by using a pulsed and a cw light source in the S-11 spectrum. This method has been found to be very useful in experiments of molecular physics where a weak spontaneous radiation to be detected is associated with a very intense pulse of stimulated radiation arising from a laser induced, coherent excitation of the medium. (auth)

31255 STUDY OF THE VARIATION OF PRESSURES IN AN ION SOURCE OF THE DUOPLASMATRON TYPE AS A FUNCTION OF THE DISCHARGE PARAMETERS. Lejeune, Claude; Prangere, Francis (CNRS, Paris. Univ., Paris, Orsay, France). Compt. Rend., Ser. A and B, 264: 1075-8(Apr. 10, 1967). (In French).

The discharge creates a strong pressure gradient between the two chambers, independent of the source. The balance of the neutral and charged particle flux makes it possible to interpret this phenomenon and to deduce from it indications of the discharge properties and the characteristics of the extracted beams. (tr-auth)

31256 METHOD FOR MEASURING DOUBLE CHARGE EXCHANGE CROSS SECTIONS OF LOW-ENERGY IONS. Kozlov, V. F.; Bondar, S. A. Zh. Tekh. Fiz., 37: 542-9(Mar. 1967). (In Russian).

A variant of the mass spectrometer technique is proposed for measuring charge exchange cross sections of low energy ions that avoids the systematic errors due to the unequal scattering of the primary and secondary particles. The technique was used to measure the cross section for the $H^+ + H_2 \rightarrow H^- + 2H^+$ reaction. The new technique is applicable to charge exchange reactions in which both the incident and scattered ions are (differently) charged and makes it possible to employ narrow entrance and exit slits to the scattering chamber, thus assuring adequate pressure difference between the scattering and analyzing chambers. In the proposed technique the incident ion beam is electrostatically deflected immediately on entering the scattering chamber. By varying the potential on the deflector plates the primary beam is swept across the exit slit, and by measuring the primary beam current as a function of the deflecting voltage one can determine the radial distribution of current in the primary beam as it leaves the scattering chamber and, by an integration, one can determine the total beam current. As the primary beam is deflected it carries with it the secondary beam, which it produces; one can therefore, at the same time and in the same way, determine the total current in the secondary beam, and thus the cross section. For the success of this technique it is essential that the primary and secondary beams be axially symmetric and that their axes pass through the exit slit for some value of the deflecting potential. The double charge exchange cross section of H^+ on H_2 was measured for incident proton energies from 0.1 to 6.0 keV. The proton beam from an arc-type source was rendered monoenergetic by a 90° magnetic analyzer, entered the approximately 50 cm long scattering chamber through a 1-mm-diameter circular aperture,

was electrostatically deflected with the aid of approximately 10-cm-long curved deflecting plates, left the scattering chamber through a 0.25-mm-diameter circular aperture, and was analyzed with a magnetic mass spectrometer. The positive ion current in the beam was measured with a Faraday cup, and the negative ion current, with a negative-ion counter. The hydrogen pressure in the scattering chamber was varied, and the final cross sections were obtained by extrapolation to zero pressure. (ATD)

31257 DIRECT MEASUREMENT BY A COINCIDENCE TECHNIQUE OF THE CROSS SECTIONS OF ELEMENTARY ATOMIC COLLISION PROCESSES INVOLVING CHARGE EXCHANGE. Afrosimov, V. V.; Mamaev, Yu. A.; Panov, M. N.; Uroshevich, V.; Fedorenko, N. V. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 37: 550-61(Mar. 1967). (In Russian).

An investigation was made of the general elementary atomic collision process in which an incident "fast" atom or ion of charge k strikes a target atom of charge t (ordinarily t = 0), continues as a "fast" particle of charge m, leaves the target particle as a "slow" particle of charge n, and liberates m + n − k − t electrons; this process they denote by the symbol ktmn. These processes are classified, and it is pointed out that by ordinary techniques one cannot measure the cross sections for the separate elementary processes that take place, but only certain averages of the cross sections for all or several of them. The apparatus developed for such measurements is described briefly, and considerations involved in the design of such equipment, its adjustment, and possible sources of error, are discussed at considerable length. In the technique discussed the primary particles, after leaving the scattering chamber, are analyzed with a magnetic spectrometer and recorded with appropriate counters, and the charged recoil particles are extracted from the target chamber with a transverse electric field and are also magnetically analyzed and counted. To measure the cross section for the ktmn process one records suitably delayed coincidences between fast particles of charge m and slow particles of charge n, the delay being introduced to compensate for the different flight times of the fast and slow particles from the target region to their respective detectors. The coincidence technique is least advantageous for ktkn processes, for in that case the primary particles that did not react are recorded by the same counter that records those that did react, and their presence greatly increases the accidental coincidence rate. It is estimated that for the case of incident protons the lowest cross sections that can be measured are about 3×10^{-19} to 10^{-21} cm^2. (ATD)

31258 ACCELERATION OF IONS BY DRIFT RESONANCE. Buffa, Antonio (CEN de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. A and B, 264: 766-9(Mar. 6, 1967). (In French).

The possibility of accelerating ions with a right polarized radio-frequency wave by utilizing a drift resonance phenomenon due to a space-charge electrostatic field crossed with a magnetostatic field is shown. This situation is obtained by injection of the ions into a cylinder of electrons radially confined by the magnetostatic field itself. (tr-auth)

Cosmic Radiation

Refer also to abstract 30725.

31259 (AD-638020) COSMIC RAY INTENSITY VARIATIONS DURING 1965. Scientific Note No. 1. Sandstrom, A. E.; Dyring, E.; Ekstrom, L.; Lindgren, S.; Sporre, B. (Uppsala Univ. (Sweden)). May 25, 1966. Contract AF 61(052)-868. 28p. (AFCRL-66-523). CFSTI.

The recorders have continued as during the last years by one neutron monitor, two cubical telescopes and six inclined telescopes in Uppsala and Kiruna. Tables and figures give a detailed account of diurnal and semidiurnal variations during 1965. Only one decrease is illustrated in a one-hour diagram. (auth)

31260 (N-66-31359) ATMOSPHERIC TRANSITION CURVES FOR GEOMAGNETICALLY-SENSITIVE COSMIC RAYS. Final Report. Good, Robert C. Jr. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). Mar. 1966. Contract NAS1-5254. 45p. (NASA-CR-66110). CFSTI.

An attempt is made to reduce some existing observational data on the nuclear cascade in the atmosphere to a form suitable for comparison with nuclear cascade calculations. This data reduction consists in removing from the observational data the contribution of primaries whose energies are too high to permit the cascades they indicate to be calculated with confidence. The procedure is similar to, though simpler than, that used in deriving specific yield functions for use in cosmic ray physics. The results are presented in a family of curves. There is an indication that the number of neutrons at any given depth in the atmosphere is not a sensitive function of the incident rigidity between ~10 and ~15 Gv. Prescriptions for comparing calculations with these or similar curves are given. Some illustrative curves for incident α particles are presented. (auth)

31261 PRELIMINARY RESULTS OF RADIATION STUDIES BY THE COSMOS-53 SATELLITE. Ignat'ev, P. P. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1818-19(Nov. 1966). (In Russian).

Studies of the energy spectrum and particle composition of the Earth's radiation belts and cosmic radiation were conducted by special instrumentation on board the Cosmos-53 satellite. Data are presented which were obtained by a gas discharge counter of the STS-5 type placed inside the satellite with a 2 g·cm^{-2} shielding. The effective area of the counter was estimated to be 4.3 cm^2. The counting rate of the gas discharge counter was determined as a function of altitude for various values of parameter L (for regions outside radiation belts). Such values of coordinates L and B for which h_{min} would be negative served as the criteria of whether the satellite was outside a radiation belt. The measurement results are illustrated. (ATD)

31262 RECORDING LOW-ENERGY PROTONS ON SATELLITES OF THE ELEKTRON SERIES. Sosnovets, E. N. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1820-3(Nov. 1966). (In Russian).

The satellites of the Elektron series have made it possible to study low-energy protons over wide regions of space during the period approaching that of minimum solar activity. Each of the four satellites carried identical sets of instruments; results obtained in various parts of space at various times could therefore be compared. The results presented deal with protons with $1 < E_p < 9$ MeV recorded by external scintillation and semiconductor counters. Crystals ~0.15- and ~3-mm thick were used in the scintillation counters. The counter with a thin crystal recorded protons with $(1.5 \pm 0.2) < E_p < (10 \pm 2)$ MeV; the counter with the thicker crystal recorded protons $(5 \pm 0.5) < E_p < (80 \pm 20)$ MeV and $(9 \pm 1) < E_p < (30 \pm 5)$ MeV. In both counters the crystal was shielded with an ~2 mg·cm^{-2} Al foil within an angle of ~40°. In all other directions the crystals were shielded with an ~1.5 to 2 cm Pb foil. Protons with $(1.0 \pm 0.2) < E_p < (5 \pm 1)$ MeV were recorded by semiconductor counters with an ~2 mg·cm^{-2} Al shielding. Preliminary measurements were used to construct proton distribution in geomagnetic coordinates. Parameter L and magnetic field strength B were employed as such coordinates. Proton intensity vs. latitude for several fixed L's, and experimental points related to proton detectors carried by different satellites are shown. Points at L = 1.3, 1.6, and 2 were obtained by Elektron-3, and points at L = 3 were obtained by Elektron-1 and Elektron-2. (ATD)

31263 STUDY OF HIGH-ENERGY ELECTRONS USING THE PROTON-1 AND PROTON-2 ARTIFICIAL EARTH SATELLITES. Grigorov, N. L.; Klintsov, Yu. S.; Nesterov, V. E.; Rapoport, I. D.; Savenko, I. A.; Yakovlev, B. M. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1773-5(Nov. 1966). (In Russian).

The instrumentation of the Proton-1 and Proton-2 satellites included an SEZ-12 electron spectrometer which could register primary cosmic radiation consisting of electrons with $E_e \geq 0.3$ BeV. The cosmic-ray electrons were measured accurately even if they numbered only 0.2 to 0.3% of the proton total. After processing the electron count data, an unexpected result became apparent for electrons with $E_e \geq 0.3$ BeV. The intensity of electrons with $E_e \geq 0.3$ BeV and protons recorded by the SEZ-12 equipment is shown as a function of latitude. Even on the equator where particles with energies less than 7 BeV/sec should not be found because of the Earth's magnetic field, 0.3-BeV/sec electrons were recorded. These, consequently, cannot be primary electrons; they are electrons which have been trapped and retained by the Earth's magnetic field. The SEZ-1 apparatus in the Proton-1 registered particles with charge Z = 1 and Z = 2 in the equatorial regions where their intensity was 1.2 (for Z = 1) and 2.1 (for Z = 2) times more predominant in the West than in the East. If it is assumed that the primary protons possess the same asymmetry, the SEZ-1 equipment recorded a flux of 2.6×10^{-2} secondary particles/cm^2·sec·sterad. Thus the existence of an electron flux ($E_e \geq 0.3$ BeV) of 2.2×10^{-2} el/cm^2·sec·sterad is corroborated by the SEZ-1 data. (ATD)

31264 MEASURING THE INTENSITY OF COSMIC RADIATION BY MEANS OF ZOND-1, ZOND-2, ZOND-3, LUNA-5, AND LUNA-6 AUTOMATIC SPACE STATIONS. Lyubimov, G. P. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1815-17(Nov. 1966). (In Russian).

Interplanetary automatic space stations of the "Zond" series carried special instrumentation for measuring cosmic rays in interplanetary space and in the Earth's radiation belts. The instrumentation consisted of scintillation and gas-discharge counters. STS-5-type Geiger counters were mounted inside the

spacecraft. Counters of the SBM-10 type were mounted inside Luna-5 and Luna-6. Results of measurements obtained with the Geiger counters are presented. A comparison of daily mean values of emission intensity measured by the interplanetary stations indicates variations in cosmic-ray intensity which are analogous to those recorded by the Luna-4 spacecraft. Maximum deviations from the mean values during measurements were ±2% for Zond-1, ±4% for Zond-4, ±5% for Zond-3, and ±6% for Luna-6. These variations in cosmic-ray intensity are related to the presence of spatial magnetic inhomogeneities in near solar space and to variations in the magnetic component of solar cosmic rays. A comparison of data on cosmic-ray intensity measured by Mars-1 and Luna-4 with data obtained by Zond-1, Zond-2, Zond-3, Luna-5, and Luna-6 reveals a further increase in intensity. (ATD)

31265 MEASURING THE VERTICAL INTENSITY OF HARD γ QUANTA AT VARIOUS ATMOSPHERIC DEPTHS. Chuikin, E. I.; Romanov, A. M.; Lenin, A. S. (Ioffe Inst. of Physics and Tech., Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1791-3 (Nov. 1966). (In Russian).

A special γ telescope was designed for measuring the vertical intensity of γ quanta with E > 70 MeV at various atmospheric heights. It consists of a scintillation detector with a 12-mm thick CsI(Tl) crystal and a total-absorption Cherenkov counter, both of which are connected in a coincidence circuit. The CaI(Tl) crystal simultaneously serves to convert γ quanta into electron–positron pairs. A plastic scintillator, connected in an anticoincidence circuit, shields the telescope from charged particles. Electron discrimination is employed to exclude possible noise from neutron "stars." The coincidence circuit is protected from signals resulting from bursts in CsI which exceed the value of a burst caused by a μ meson during its passage through the CsI crystal perpendicularly to the plane of the plate. Geometrical factor Γ of the telescope is determined by the radiation pattern and the effective area of the system. The average value of Γ is 2 ± 0.15 cm^2 sterad. The lower energy threshold of recorded γ quanta is determined by a discriminator in the channel of the Cherenkov radiator. The threshold value was determined by calibration of the radiator on a synchrotron and a meson telescope. The threshold was established from the ratio of signals from γ quanta and μ mesons. The efficiency of recording γ quanta by the telescope depends on the efficiency of pair formation in CsI and on the threshold of a differential discriminator in the CsI channel. For $E_\gamma = 100$ MeV this efficiency was 0.25 ± 0.08. Transistors and tunnel diodes are used in all the components. The averaged results of balloon measurements conducted at a geomagnetic latitude of 40° and atmospheric depths of 7, 8, and 12 mbar are shown. The maximum of the curve is observed at latitudes of 10 to 20 km and corresponds to $I_{max} = 40 \times 10^{-3}$ cm^{-2} · sec^{-1} · sterad^{-1}. (ATD)

31266 INTENSITY MEASUREMENTS OF ELECTRONS IN PRIMARY COSMIC RADIATION. Rubtsov, V. I. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1789-90(Nov. 1966). (In Russian).

Measurements results of the electron component of primary cosmic rays obtained during the flights of high-altitude balloons in October 1964 and in August 1965 are reported. The basic measuring system consists of two plastic scintillator counters with a diameter of 250 mm, a thickness of 35 mm, and an angular factor $\Omega s = 200$ cm^2 steradian. The total thickness of lead absorbers was equal to the σ radiation units. On the basis of the data, determination was made of the stream of γ quanta with energy ≥ 3.5 BeV which were generated during the disintegration of π^0 mesons, created during nuclear interaction of the cosmic rays in the vicinity of the boundary of the atmosphere in 1 gr · cm^2 of air. The differential energetic spectrum of primary electrons is shown. It is seen that there is a disagreement between data of the present paper and data on electron intensity obtained by radioastronomical methods. The conclusion is made that the common energy spectrum of primary electrons can be constructed for the energy range of 0.5 to 26 BeV. (ATD)

31267 DETERMINATION OF THE POSITION OF THE COSMIC-RAY EQUATOR BASED ON RESULTS OF MEASUREMENTS MADE WITH THE PROTON-1 SATELLITE. Basilova, R. N.; Volodichev, N. N.; Nesterov, V. E.; Savenko, I. A. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1771-2(Nov. 1966). (In Russian).

Directional equipment for registration of cosmic particles was mounted on the Proton-1 satellite. The equipment consisted of two SEZ-1 scintillation counters capable of recording energy spectra of protons and cosmic-ray nuclei with energies from 0.2 to 30 BeV. These counters, when used in a double-coincidence scheme, are also capable of measuring protons and electrons with energies higher than 100 and 20 MeV at a solid angle of ~3 sterad. This double-coincidence scheme, which can register particles incident from opposite directions, was chosen to record the positions of points of minimum cosmic-ray intensity. The results are compared with the results obtained with a single Geiger counter averaged for the Kosmos-4 and Kosmos-7 satellites. (ATD)

31268 SOME PRELIMINARY RESULTS OF A STUDY OF INTENSITY VARIATIONS OF COSMIC RAYS CARRIED OUT BY THE KOSMOS-25 SATELLITE. Kuzhevskii, B. M.; Salimzibarov, R. B.; Skryabin, N. G.; Shafer, Yu. G. (Inst. of Space Physics Research and Aeronomy, Yakutsk, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1776-7(Nov. 1966). (In Russian).

The satellite Kosmos-25 was launched on 27 Feb. 1964 to study cosmic-ray variations. The measuring equipment installed on board the satellite included shielded and unshielded gas-discharge counters, a shielded scintillation-counter array, and an ionization chamber. On the basis of monthly mean values of readings of these devices, several assumptions concerning the relationship between variations in cosmic-ray intensity and solar activity were made. Instrument readings were taken for the energy threshold $P_0 = 4$ BeV with reference to an altitude of 350 km. The information obtained from the array and from the shielded and unshielded counters indicate a 30-day lag in the variations in cosmic-ray intensity in respect to the variations in solar activity. The ionization chamber readings characterize the ionizing power of particles more than it does their intensity. It is indicated that the chamber readings increase when particle intensity, recorded by the counter, is decreased. In a number of cases additional radiation was recorded by the shielded counter, the effect of which increased during flight of the satellite at low latitudes. It is assumed that these phenomena can be attributed to either the recording of electron–positron pairs developed by γ quanta, the effect of x rays on the shield of the counter, or solar x radiation during atmospheric flares. (ATD)

31269 MEASUREMENT OF THE ENERGY SPECTRUM OF PRIMARY COSMIC RAYS IN THE REGION OF 10^{10} TO 10^{14} eV USING THE PROTON-1 SATELLITE. Grigorov, N. G.; Kovrizhnykh, O. M.; Nesterov, V. E.; Rapoport, I. D.; Savenko, I. A.; Skuridin, G. A.; Titenkov, A. F. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1760-2(Nov. 1966). (In Russian).

The energy spectrum of primary cosmic rays with energies between 10^{10} and 10^{14} eV was measured using equipment mounted on the Proton-1 satellite. The ionization calorimeter method of measurement was employed using SEZ-14 equipment. Spectra of protons with energies between 5×10^9 to 10^{12} eV and of all particles (protons and heavier particles) with energies between 2×10^{10} to 10^{14} eV were measured, although the charge of particles with energies between 2×10^{10} and 10^{14} eV was not determined. The energy spectrum obtained from data taken during a 36-hour period for protons and a 50-hour interval for all other particles is given. It is noted that the cited results are preliminary, since they are obtained from a small part of the data. (ATD)

31270 STUDY MADE USING THE PROTON-1 SATELLITE OF THE CHEMICAL COMPOSITION OF PRIMARY COSMIC RAYS IN THE MEDIUM-ENERGY REGION. Volodichev, N. N.; Grigorov, N. L.; Nesterov, V. E.; Rapoport, I. D.; Savenko, I. A.; Yakovlev, B. M. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1763-4 (Nov. 1966). (In Russian).

A study, made using the Proton-1 satellite, of the flux and chemical composition of solar cosmic rays generated during chromospheric flares, and of primary galactic cosmic radiation is described. A nuclear charge spectrometer with a geometric factor of 133 ± 6 cm$^2 \times$ sterad was used in the study. The spectrometer consisted of a Cherenkov counter placed between two scintillation counters which form a telescope. The Cherenkov counter consisted of an FEU-49 photomultiplier which made an optical contact with a Plexiglas disk 165 mm in diameter and 30-mm thick. The side of the disk opposite the photocathode was coated with black paint to prevent registration of upward moving particles. The scintillation counters consisted of FEU-13 photomultipliers and plastic scintillator plates 15-mm thick. Graphs of cosmic ray flux vs. hardness were constructed from the preliminary data on the longitudinal effect and azimuthal asymmetry of cosmic-ray intensity in the geomagnetic equator region for protons, α particles, and nuclei in the M, H, and VH groups with energies of 1 BeV for protons and in the range of 2 to 19 BeV for the remaining groups. (ATD)

31271 HIGH-ENERGY γ QUANTA AT THE UPPER LIMITS OF THE ATMOSPHERE. Grigorov, N. L.; Kalinkin, L. F.; Melioranskii, A. S.; Nesterov, V. E.; Pryakhin, E. A.; Savenko, I. A.; Estulin, I. V. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1765-7(Nov. 1966). (In Russian).

The satellites Proton-1 and Proton-2 carried equipment designed to detect gamma rays with energies above 50 MeV and to measure their spectrum. The equipment comprised a telescope formed by a γ-quanta converter consisting of a sandwiched plastic scintillator, and a Cherenkov counter with a radiator

made from lead-containing glass which detected the energy and direction of γ rays. The telescope detectors were placed inside a cover made of a scintillator plastic which protected the telescope from the noise of charged particles in selection of anticoincidences. In addition to gamma radiation, the equipment was capable of registering pulses from other electrically neutral particles (neutrons for example), as well as the flow of charged particles with energies that exceeded the luminescence threshold of the Cherenkov counter radiator. The flow of γ quanta with energies exceeding 5 MeV was approximately 2×10^{-3} cm^{-2} sterad^{-1} sec^{-1}; this value is in good agreement with the values obtained by other researchers. (ATD)

31272 RESULTS OF COSMIC-RAY STUDIES BY THE ELEKTRON-2 AND ELEKTRON-4 SATELLITES. Okhlopkov, V. P. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1824-6(Nov. 1966). (In Russian).

Experimental data are presented on primary cosmic rays obtained by a gas discharge counter with a 2.3 g·cm^{-2} shielding onboard the Elektron-2 and Elektron-4 satellites. The area of the counter carried by Elektron-4 exceeded by 1.06 that of the counter carried by Elektron-2. The threshold energy for recording protons by this counter was 48 MeV. The average counting rate of the gas discharge counter was approximately 20.5 pulse/sec which, over a 20-hr period during which the satellites were outside the radiation belts in each orbit, assured a statistical accuracy of 0.5 to 1.0% for Elektron-2 and 0.1 to 0.3% for Elektron-4. Counting-rate values were obtained for the period January 30, 1964, to February 9, 1965. There were two types of variation in cosmic-ray intensity: slow variations associated with the 11-year cycle of solar activity, and fast variations associated with a period of two weeks. In the first half of 1964 the intensity of primary cosmic rays continued to increase. For the period February–May this increase was about 10%. At the same time on the IMP-1 satellite a 15% increase was observed. For the period February–May the intensity grew at an average rate of 2%, in the period July–August at a rate of 1% per month, and in September and October the intensity remained constant. This increase in the intensity of primary cosmic rays is well correlated with an increase in the intensity of the neutron component. (ATD)

31273 STUDY OF TIME CHANGES OF NUCLEAR FLUX IN PRIMARY COSMIC RADIATION ON ELEKTRON-2 AND ELEKTRON-4 SATELLITES. Blokh, Ya. L.; Dorman, L. I.; Kurnosova, L. V.; Razorenov, L. A.; Raichenko, L. V.; Suslov, A. A.; Fradkin, M. I. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1755-9(Nov. 1966). (In Russian).

Some results of a study of primary cosmic radiation conducted using the Elektron-2 and Elektron-4 satellites are given. An integral Cherenkov counter was placed in each satellite to measure fluxes of nuclei with energies greater than 600 MeV/nucleon. Those nuclei belonging to groups $Z \geq 2$, $Z \geq 5$, $Z \geq 15$ were measured by the Elektron-2, and those of group $Z > 20$ by the Elektron-4. Average flux values measured for the above groups of nuclei relative to the average flux values obtained during July 1964 are given. The data cover the period from Jan. 30,, 1964, through Feb. 9, 1965. The fluxes measured at midday by the satellites are in close correlation with those measured by the ground stations for quiet ground conditions. It is noted that nuclear flux increased by a factor of 1.7 to 2 during the period from 1959 to 1964. During the same period the flux registered by a neutron monitor at the Climax ground station increased by about 20%. During 1964 to 1965 the nuclear flux increased by about 15% for nuclei with $Z \geq 2$ and $Z \geq 5$. The accuracy of measurements of the flux increase of nuclei with $Z > 20$ during the flight of the Elektron-4 satellite was impaired by several rises in flux and by significant statistical errors. (ATD)

31274 ANNUAL VARIATIONS OF COSMIC RAYS AND CHANGES OF THE COSMIC RADIATION INTENSITY AS A FUNCTION OF THE HELIOLATITUDE OF THE EARTH. Dorman, L. I.; Luzov, A. A.; Mamrukova, V. P. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow. Siberian Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Irkutsk, USSR). Dokl. Akad. Nauk SSSR, 172: 833-6(1967). (In Russian).

The considerable disagreement on the nature of the annual variation of the intensity of cosmic rays is reviewed. An analysis of 1960 data indicates that while the hard component of cosmic rays includes a wave with a 12-month period, the neutron component does not include such a wave. This appears to suggest that the annual temperature change of the atmosphere has a considerable influence upon the seasonal variation of the hard component. The expected seasonal variation of the hard component was calculated using radiosonde soundings data up to a 50-mb level. The obtained annual wave has distinctly pronounced maxima near the equinoxes. Such agreement between the neutron and hard components suggests that the origin of this variation is extra-atmospheric. This appears to support Dorman's theory of meteorological phenomena. An analysis of 11-year variations of the intensity of cosmic rays performed by the Pioneer-V suggest the existence of a radial gradient of density of cosmic rays in interplanetary space which is <1%/0.1 amu. It appears to follow that a shift of the earth's position with respect to the plane of the solar equator in the presence of a transverse gradient of cosmic radiation intensity might lead to a peculiar variation of the intensity of the cosmic rays on earth in time. The unique distribution of the intensity of cosmic rays on earth, as a function of the heliolatitude, indicates the existence of an area in the interplanetary space where the intensity of cosmic rays is minimal. This area is near the solar equator. (ATD)

31275 PARAMETERS OF FORBUSH EFFECTS AND FLARES. Gopasyuk, S. (Astrophysical Observatory, Crimea, USSR); Krivsky, L. Bull. Astron. Inst. Czech., 18: 125-35(1967).

The following parameters of Forbush effects were determined from cosmic-radiation recordings of the Deep River Station (Canada) for 1959 to 1964: the time lags of the beginnings of the effects behind the flare, the duration of the descending phase, the maximum drop in per cent and the speed of the drop. 79 typical effects were processed, for 51 of which were determined the flares with magnetic bottles pulled out into the space about the Earth with subsequent Forbush effects. The criterion for determining the flare was complex and rather severe. The variation in the number of effects with regard to the solar cycle and the distribution of flares over the disc were examined. The statistical distribution of the individual parameters of Forbush effects and their mutual relations were investigated. The values of the individual parameters were also investigated with regard to the importance and longitudinal position of the flares. Other relevant relations were interpreted. (auth)

31276 EFFECTS OF SYSTEMS OF MAGNETIC BOTTLES FROM FLARES. Gopasyuk, S. (Astrophysical Observatory, Crimea, USSR); Krivsky, L. Bull. Astron. Inst. Czech., 18: 135-43(1967).

Continuous cosmic-radiation recordings by neutron monitors made at one station from 1959 to 1964 were used to investigate both Forbush effects and the flares which caused them. It was found that such effects originate, as a rule, in flares from one and the same active solar region. In a number of cases (8 on the whole), however, a succession of Forbush effects resulted from flares in different active regions. In all these cases, each new Forbush effect forming in the afterglow phase of the preceding effect or shortly after was invariably provoked by a flare eastward of the flare responsible for the preceding effect. One of the possible interpretations of this phenomenon is given. It appears that magnetic bottles may encounter in interplanetary space and interlock their magnetic fields. Phenomena are discussed which may occur in the solar corona and in interplanetary space as consequences of the process of reconnecting magnetic fields. The energy of a magnetic bottle and maximum density of particles for the distance of the Earth's orbit are estimated. (auth)

31277 A STUDY OF THE EFFECTIVENESS OF THE MCILWAIN COORDINATES IN ESTIMATING COSMIC-RAY VERTICAL CUTOFF RIGIDITIES. Smart, D. F.; Shea, M. A. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Geophys. Res., 72: 3447-54(July 1, 1967).

The classical vertical cutoff rigidity equation $P_c = M \cos^4 \lambda / 4r^2$ can be used with the McIlwain R, λ_m coordinates to include the effects of the eccentricity of the geomagnetic field. Using the equation $R = L \cos^2 \lambda_m$ cosmic-ray cutoffs can be expressed by $P_c = KL^\gamma$ where K and γ are evaluated by a least-squares fit of the vertical cutoff rigidities as determined by (a) Quenby and Wenk, (b) Makino, and (c) Shea, Smart, and McCracken. None of these data sets result in the intuitively expected equation $P_c = 14.9L^{-2}$. The coefficients obtained range in value from 15.02 to 16.69 depending upon the data set considered, but in all cases the exponent is very near the expected value of –2. It is concluded that the McIlwain coordinates are highly correlated with vertical cutoff rigidities with the best correlation, $P_c = 15.96L^{-2.005}$, being obtained using the Shea et al. trajectory-derived cutoff values. This equation can be used for estimates of vertical cosmic-ray cutoff rigidities on or above the earth's surface with the exception of points near the cosmic-ray equator. (auth)

31278 DIFFERENTIAL RESPONSE AND SPECIFIC YIELD FUNCTIONS OF COSMIC-RAY NEUTRON MONITORS. Lockwood, J. A. (Univ. of New Hampshire, Durham); Webber, W. R. J. Geophys. Res., 72: 3395-3402(July 1, 1967).

From the recent neutron monitor latitude survey by H. Carmichael and from the primary spectrum measurements by W. Webber, both at solar minimum, new differential response and specific

yield functions of cosmic-ray neutron monitors located at sea level and mountain elevations with vertical cutoff rigidities in the interval $0.7 < P_c < 10$ GV are deduced. The differential response functions at sea level are larger than the previously calculated values at rigidities $P < 3$ GV. The proton specific yield function at sea level is obtained and can be represented by $KP^{+2.6}$ for $2.5 < P < 6$ GV. The relative contributions of primary nuclei with $Z \geq 2$ to the counting rate of a sea-level neutron monitor as a function of P_c are evaluated. The change in the differential response functions between 1963 and 1965 was used to determine the change in the primary differential cosmic-ray spectrum. The decrease in the observed differential primary spectrum agrees well with the decrease in the neutron differential response function in the rigidity range where they can be compared. (auth)

31279 INFLUENCE OF COSMIC MEDIUM MOTION ON POLARIZATION OF COSMIC RADIATION. Getmantsev, G. G.; Paseka, A. M.; Tokarev, Yu. V. (Scientific-Research Radiophysics Inst., Gorky, USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 10: 599-602(1967). (In Russian).

The expressions are discussed for the difference of the refractive indices of normal waves propagating in a two-component medium which consists of plasma flow moving in a quiescent plasma. The influence is estimated of cosmic plasma flows on the character of the radiation polarization of different cosmic objects. (auth)

Direct Energy Conversion

31280 (BMwF-FBK-67-46) WISSENSCHAFTLICHER BERICHT, 1966. (Status Report, 1966). (Technische Hochschule, Stuttgart (West Germany). Institut fuer Kernenergetik). May 1967. 365p. (In German). Dep.

A status report of the research work in the field of thermionic reactors as power supply for space crafts carried out at the Institut für Kernenergetik der Technischen Hochschule Stuttgart in 1966 is presented. The contributions are dealing with reactor physics, neutron and γ-ray shielding, theoretical and experimental investigations in thermionic converter physics and problems of heat transfer by fin-tube radiators and heat-pipe radiators. (auth)

31281 (R-67SD-34) THE STEADY STATE CONTROLLED DISCHARGE LINEAR NON-EQUILIBRIUM MAGNETOGASDYNAMIC GENERATOR. Evans, Norman A. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). June 1967. 38p.

Experimental results are presented which demonstrate the basic feasibility of extracting appreciable steady electrical power from a plasma in a state of significant nonequilibrium ionization when flowing at high speed through a magnetic field. The work was carried out in a cesium-seeded argon blowdown facility at a stagnation temperature of 1500°K, Mach numbers up to 0.6 and a magnetic field strength of 22,500 gauss. Each of the eleven channel electrode pairs was equipped with a discharge holder in the form of a small diameter ceramic tube between the electrodes. This device controlled the current path through beneficial interference by acting in a manner analogous to a simple flame holder, producing, especially at the generator entrance, a considerable improvement in both discharge steadiness and voltage efficiency. During uniform Faraday mode power extraction from the last seven electrode pairs the transverse electrical conductivity was approximately 150 times the corresponding thermal equilibrium value, and traversable probe readings showed that the induced Faraday electric field exceeded 90% of the theoretical value. It was concluded that pure magnetically induced ionization is impractical on account of the low ionization rate, and in the present experiment this problem was overcome by the expenditure of appreciable input pre-ionization power through the first four electrode pairs. (auth)

31282 (AD-804130) ANALYSIS OF CERTAIN PROBLEMS PERTAINING TO THE OPERATION OF A DC MHD GENERATOR. Milewski, Jerzy. Translated from Pr. Inst. Masz. Przeplyw., No. 17, 109-30(1963). 32p. (FTD-HT-66-216). CFSTI.

A brief analysis concerning a dc MHD generator, the main emphasis being placed on the problem of the operation of the electrodes of the generator and the possibility of applying nonthermal plasma ionization, is given. (auth)

31283 DETERMINATION OF THE BASIC PARAMETERS OF AN INDUCTION MAGNETOHYDRODYNAMIC GENERATOR. Kant, Michel (CNRS, Fontenay-aux-Roses, France). Compt. Rend., Ser. A and B, 264: 773-5(Apr. 24, 1967). (In French).

A mathematical model is proposed for an induction MHD generator, corresponding to the electrical scheme deduced from the basic equations of the electromagnetic field. (tr-auth)

31284 EXPERIMENTAL INVESTIGATION OF SOME PARTICULARITIES OF ELECTRON MOTION IN A CROSSED-FIELD THERMIONIC CONVERTER. Bacal, Martha; Teodorescu, Maria (Inst. for Atomic Physics, Bucharest). pp 397-410 of Third Czechoslovak Conference on Electronics and Vacuum Physics, Transactions, Held in Prague on September 23rd–28th, 1965. Paty, Libor (ed.). Prague, Publishing House of the Czechoslovak Academy of Sciences, 1967.

See CONF-650987.

The cutoff characteristic and the influence of emission current density were studied for a crossed-field device called the magnetic triode, which is used for direct thermionic conversion of heat to electricity. (M.O.W.)

31285 RECENT DEVELOPMENTS IN LIQUID-METAL MHD POWER SYSTEMS. Petrick, Michael. Power Reactor Technol., 9: 187-93(Fall 1966).

This article briefly summarizes recent significant advances in liquid-metal MHD cycles, which were discussed in detail for the first time at the 3rd Symposium on MHD Electrical Power Generation, Salzburg, Austria, July 4-8, 1966 (for references to individual papers see the Report Number Index of NSA Vol. 20, Nos. 21 and 22, at the entry CONF-660704). It is emphasized that the future of MHD power generation is very closely related to the direction and rate of development of nuclear power reactors. Discussion is primarily devoted to the following major areas which have received and are continuing to receive the most intensive study: (1) generator performance, (2) methods for liquid acceleration, and (3) cycles. (TSS)

31286 DIAGNOSTICS OF A LOW-TEMPERATURE CESIUM PLASMA. Volkov, N. V.; Gus'kov, Yu. K.; Pashchenko, V. P. Zh. Tekh. Fiz., 37: 504-12(Mar. 1967). (In Russian).

Transport phenomena in a cesium-filled flat diode are described by diffusion equations which establish the dependence of the electron and ion fluxes on concentration gradients and plasma potentials. The equations are solved on the assumption that, at the saturation-current mode of operation, the electron and ion temperatures can be approximated by a linear function of the distance. Similarly, from the diffusion equations, a formula is obtained for the potential drop in the interelectrode spacing. The solutions of the transport equations also comprises values which depend on the potential jump near the electrodes, and formulas are derived for their calculation. The results are compared with experimental probe measurements and the parameters at which the anomalous low-voltage arc occurs are determined. (ATD)

31287 PLANTS FOR GENERATING ELECTRICAL ENERGY BY MEANS OF A MAGNETOHYDRODYNAMIC GENERATOR. (to Brown Boveri and Co. Ltd.). British Patent 1,071,727. June 14, 1967. Priority date Sept. 30, 1964, Switzerland.

The plant for generating electrical energy consists of the following: a magnetohydrodynamic generator, at least one high-temperature and one low-temperature heat exchanger disposed in the exhaust line of the generator and adapted by means of the heat in the exhaust gases to preheat the combustion air or working gas before it enters the generator. (M.O.W.)

31288 METHOD AND APPARATUS FOR PRODUCING ELECTRICAL IMPULSES USING A MAGNETOHYDRODYNAMIC GENERATOR. (to AVCO Corp.). British Patent 1,072,419. June 14, 1967. Priority date Nov. 1, 1963, United States.

A method is discussed for producing electrical impulses in a load connected in parallel with an inductor, comprising the steps of passing a hot electrically conductive gas between a pair of opposed electrodes in a magnetic field in a magnetohydrodynamic generator to generate electrical energy by introducing a unidirectional electromotive force between the electrodes. Part of the electric energy is inductively stored by establishing a flow of current in a predetermined direction from the electrodes through the inductor while the current is prevented from flowing through the load. Then, part of the stored electrical energy is released to the load by suddenly reducing the electric conductivity of the gas. Also some of the stored electric energy is used to supply part of the magnetic field for the magnetohydrodynamic generator. (M.O.W.)

31289 IMPROVEMENTS IN AND RELATING TO MAGNETOHYDRODYNAMIC ELECTRICITY GENERATING SYSTEMS. Engel, Manfred Otto (to International Research and Development Co. Ltd.). British Patent 1,072,630. June 21, 1967. Filed Dec. 18, 1964.

A magnetohydrodynamic electricity generating system employing jet pumps or compressors is described. The jet pumps or compressors work on the ejector or injector principle and consist of a nozzle located in a duct. (M.O.W.)

31290 ELECTRODE FOR USE AT HIGH TEMPERATURES IN A CORROSIVE MEDIUM, AND A PROCESS FOR THE MANUFACTURE OF THE ELECTRODE. Poncelet, Jacques; Blum, Pierre; Bochirol, Louis; Moreau, Claude (to Commissariat a l'Energie Atomique). British Patent 1,072,383. June 14, 1967. Priority date July 3, 1964, France.

An electrode with good electric conductivity at temperatures of 2000 to 3000°K, with relatively low heat conductivity, and with high chemical and mechanical strength at the temperature specified in a corrosive medium is described. Electrodes of this type are for use in magnetohydrodynamic converters. (M.O.W.)

Fluid Physics

Refer also to abstract 31344.

31291 GREEN'S INTEGRAL FORMULAS IN MAGNETOHYDRODYNAMICS. Agostinelli, Cataldo (Univ., Turin). Meccanica, 1: 3-17(Dec. 1966).

For a demonstration of the usefulness of these formulas in the field of magnetofluid dynamics, the integral formulas of Green (cf. Acta Math., B34: 205-84(1911)) were extended to the movement of an incompressible viscous fluid, electrically conductive, in which a magnetic field is generated. In the first part, integral equations were established which define at a point within a spatial region limited by a closed surface which is variable with time, and at a given instant, the Cartesian components of the velocity of a fluid particle, the total pressure (hydrodynamic and magnetic), and the components of the magnetic field, by the values of the same quantities at the initial instant in the whole region, and by means of the values of the same and of their normal derivatives on the limiting surface. In the second part, similar formulas were established for the plane case, in which the motion occurs parallel to a fixed plane, selected as the plane xy, and the elements of the motion and of the magnetic field are functions only of x, y, and the time t. In this case two possibilities for the magnetic field are considered: either it is orthogonal to the plane of motion, or it is parallel to this plane, with an eventual constant component in a perpendicular sense. In both cases formulas were deduced relative to a plane region limited by a closed curve which is, in general, variable according to time. (BBB)

31292 THE TENSOR VIRIAL-THEOREM INCLUDING VISCOUS STRESS AND THE OSCILLATIONS OF A MACLAURIN SPHEROID. Rosenkilde, Carl E. (Argonne National Lab., Ill.). Astrophys. J., 148: 825-32(June 1967).

The tensor virial theorem is extended to include viscous stress. By using the virial method it is verified that a slightly viscous Maclaurin spheroid is unstable (with respect to second-harmonic deformations of the toroidal type) beyond the classical point of bifurcation (where the eccentricity of a meridional section exceeds 0.8127). The corresponding criteria operative in the case of a rotating, charged, liquid drop (of interest in nuclear fission theory) are discussed in the Appendix. (auth)

31293 MAGNETOHYDRODYNAMIC FLOW IN AN INSULATED RECTANGULAR DUCT WITH AN OBLIQUE TRANSVERSE MAGNETIC FIELD. Sloan, D. M. (Univ. of Strathelyde, Glasgow). Z. Angew. Math. Mech., 47: 109-14(Mar. 1967).

An exact solution is presented for the steady laminar flow of a viscous, incompressible, electrically conducting fluid in an insulated rectangular channel, with an imposed transverse magnetic field inclined at an angle to the channel walls. An asymptotic representation of the mean velocity is found in the case of a large magnetic field inclined at a small angle to one pair of sides, and numerical results are included which show the effect of rotating the applied field. (auth)

31294 STABILITY OF TRANSVERSE OSCILLATIONS IN A QUASI-ONE-DIMENSIONAL FLOW OF CONDUCTING GAS. Artyushkov, E. V. Teplofiz. Vysok. Temp., 4: 776-85(Nov.-Dec. 1966). (In Russian).

The stability of conducting, quasi-one-dimensional gas flow in a magnetic field was studied in relation to the oscillations spreading across the flow channel. Equations were obtained for small oscillations, and the stability of short-wave oscillations was studied. (tr-auth)

31295 SINGULAR PERTURBATION PROBLEMS OF LAMINAR FLOW IN A UNIFORMLY POROUS CHANNEL IN THE PRESENCE OF A TRANSVERSE MAGNETIC FIELD. Shrestha, G. M. (Queen's Coll., Dundee, Scotland). Quart. J. Mech. Appl. Math., 20: 233-46(May 1967).

The flow of a viscous, incompressible, and electrically conducting fluid in a two-dimensional channel with porous walls, through which fluid is uniformly injected or extracted, is considered in the presence of a transverse magnetic field. The problem is reduced to solving a fourth-order nonlinear differential equation which depends on a suction Reynolds number R and a Hartmann number M. A solution of this equation, valid for large suction Reynolds number and all values of Hartmann number, was given by Terrill and Shrestha without proceeding to obtain outer and inner expansions separately. These authors have also given a solution for small values of M^2/R with large negative R. In the present paper the technique of outer and inner expansions is used to solve the equation for large values of R (positive and negative) and different values of M. In particular a magnetic-boundary-layer type solution is obtained for large negative R and large M^2/R. A formal asymptotic solution is obtained for the case of large positive R and an arbitrary value of M. The resulting asymptotic solutions are confirmed by the numerical solution of the equation. (auth)

31296 GEOMETRY OF MAGNETOHYDRODYNAMIC FLOW. Wasserman, Robert H. (Michigan State Univ., East Lansing). Quart. J. Mech. Appl. Math., 20: 219-31(May 1967).

Two different systems of partial differential equations are derived, each equivalent to the Lundquist equations. In the new systems the dependent functions are functions describing the streamline and field line congruences. These formulations are then used to show precisely to what extent the geometry of the streamlines and field lines determines the flow. (auth)

31297 STABILITY OF PARALLEL FLOW IN AN OSCILLATING MAGNETIC FIELD. Drazin, P. G. (Univ. of Chicago). Quart. J. Mech. Appl. Math., 20: 201-18(May 1967).

Equations are derived for the stability of unsteady plane parallel flow of a viscous electrically conducting incompressible fluid in an unsteady parallel magnetic field. A Squire transformation is valid, but, with general considerations of parametric instability, it implies in general that some three-dimensional disturbance is the most unstable when the basic flow is periodic in time. Some sufficient conditions of stability for general flows are found from the energy equation. The parametric instability of a steady vortex sheet of inviscid fluid in an oscillating magnetic field is studied in detail. This special case is reduced to a Floquet system, and stability diagrams are calculated. They show that, with given maximum intensity of field, it is less efficient to stabilize the vortex sheet with an oscillatory field than a steady one. (auth)

31298 STUDY AND EXPERIMENTAL DEVELOPMENT OF A DEVICE DESIGNED FOR THE MEASUREMENT OF LOCAL VELOCITIES IN MAGNETOHYDRODYNAMIC FLOWS. Amy, Josette; Dorlhac, Francois; Poirier, Yves (Faculte des Sciences, Marselle-Luminy, France). Compt. Rend., Ser. A and B, 264: 641-3(Apr. 3, 1967). (In French).

A procedure for the measurement of velocities in an electroconducting liquid flow evolving in a uniform magnetic induction normal to the general direction of the flow was studied. The sensitivity of the system used and the effect of the magnetic induction on the value of this sensitivity were determined. (tr-auth)

31299 LAMINAR BOUNDARY LAYER FOR A SPIRAL MAGNETOHYDRODYNAMIC FLOW OVER A DIELECTRIC DISC. Glazov, O. A. (Inst. of Physics and Power Engineering, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 1, 51-6 (1967). (In Russian).

The laminar boundary flow in the presence of a homogeneous magnetic field perpendicular to the plane of the disc is discussed. The expressions for the liquid velocity and the electric field density in the outer flow were derived from the solution of the two-dimensional problem on the vortex hydrodynamic flow of incompressible liquids. The solution is valid in the case of sufficiently great parameters of magnetic interaction. (auth)

31300 HEAT EXCHANGE IN THE STAGE OF MHD FLOW STABILIZATION IN A PLANE CHANNEL. Blum, E. Ya.; Tsepure, I. Ya. (Inst. of Physics and Power Engineering, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 1, 57-64(1967). (In Russian).

Some results of a numerical calculation for the development of the one-dimensional laminar magnetohydrodynamic flow temperature field at simultaneous hydrodynamic stabilization are presented. By forming the Hartmann flow the intensity increase in the cross-sectional magnetic field was found to depend on the value of Prandtl's criterion. The influence was on the heat exchange characteristics of the viscous and Joule's dissipations is also discussed. (auth)

31301 NONISENTROPIC MAGNETOHYDRODYNAMIC FLOW WITH AN OBLIQUE FIELD. Gundersen, Roy M. (Univ. of Wisconsin, Milwaukee). Z. Angew. Math. Phys., 18: 294-6(Mar. 25, 1967).

The unsteady and nonisentropic one-dimensional flow of a perfectly conducting, compressible fluid subjected to the action of an oblique magnetic field with two nonzero components is analyzed

for the case when two components of the induction vector are nonzero. (tr-auth)

31302 RAYS IN RELATIVISTIC MAGNETOHYDRODYNAMICS. Lichnerowicz, Andre (College de France, Paris. CNRS, Paris). Compt. Rend., Ser. A and B, 264: 715-20(Apr. 10, 1967). (In French).

The infinitesimal discontinuity operator δ is defined in terms of distribution. The basic property of the rays associated with sonic, magnetosonic, and Alfven waves are given. The direction of the waves is invariant for δ for sonic waves and Alfven waves; it is not the same for magnetosonic waves. (tr-auth)

31303 MAGNETOFLUID MECHANICS. Ferraro, V. C. A.; Plumpton, C. (eds.). 2nd Edition. Oxford, Clarendon Press, 1966. 254p. 50s.

The subject is covered under the following main headings: historical introduction; magnetohydrodynamics (introduction and fundamental equations, magnetohydrostatics and steady states, magnetohydrodynamic waves, hydromagnetic shock waves, stability, turbulence); and plasma dynamics (motion of charged particle in a magnetic field, dynamics of a plasma wave in a plasma). (UK)

31304 PROCEEDINGS OF THE SUMMER SEMINAR IN MAGNETOHYDRODYNAMICS, BANGALORE, INDIA, MAY, 1963. Bhatnagar, P. L. (ed.). Bangalore, India, Indian Institute of Science, 1965. 383p. (CONF-630510).

Twenty-six papers were given concerning magnetohydrodynamics and plasmas. The main topics were wave behavior, stability, kinetic equations, oscillations, and hydromagnetic flow. (M.O.W.)

Geophysics

Refer also to abstracts 30533, 30534, 31260–31263, and 31420.

31305 (AD-637479) SCIENTIFIC CONTRIBUTIONS OF SPACE PHYSICS GROUP. Scientific Report. Ahluwalia, H. S.; Escobar, V. I.; Zubieta, M.; Anda, R.; Schrier, M. (Universidad Mayor de San Andres, La Paz (Bolivia). Laboratorio de Fisica Cosmica de Chacaltaya). 1965. Contract AF-AFOSR-319-64. 87p. (AFOSR-66-0834). CFSTI.

The following are discussed: solar daily variation recorded at a low-latitude station by east- and west-pointing telescopes during a period of maximum and minimum in solar activity; characteristic effects of the deformed magnetic field of the earth on medium-energy cosmic rays; and a case of transient anisotropy during the recovery phase of a Forbush decrease. (auth)

31306 (N-66-22351) ANALYSIS OF POLAR CAP ABSORPTION EVENTS. I. EFFECT OF SOLAR AND SOLAR INDUCED CONDITIONS PRIOR TO THE PCA EVENTS. Final Report. Jonah, Fred C. (LTV Aerospace Corp., Dallas, Tex. LTV Astronautics Div.). Dec. 17, 1965. Contract NAS9-4911. 89p. (NASA-CR-65323). CFSTI.

Solar and solar-induced terrestrial phenomena were analyzed a few days before and after the occurrence of solar flares which produced proton streams that were detected as polar cap absorption (PCA) events. These data were used as a basis for predicting dangerous radiation conditions outside the earth's atmosphere, their magnitude, and the time available for protective action. Plage regions, sunspot groups, flares, loop prominences, short wave radio fadeouts, solar radio emissions at discrete frequencies, and spectral emissions of Type II and Type IV that are reliably associated with PCA events were studied. It was found that if a proton event is observed, there is a high probability that the flare occurred in a large magnetically complex sunspot group, although such groups rarely have proton producing flares. Large bright and flare productive plage regions did not appear necessary for the production of a PCA flare. A 3^+ importance flare associated with a solar radio burst and short wave radio fadeout probably would be followed by a PCA event, as would a loop prominence associated flare. Solar magnetic conditions apparently do not influence flare proton delay time or magnitude. Recommendations for further observations are made. (STAR)

31307 (N-66-39695) A METHOD FOR THE DETERMINATION OF MEAN IONOSPHERIC HEIGHT FROM SATELLITE SIGNALS. Scientific Report No. 278. Kuntman, Daryal (Pennsylvania State Univ., University Park. Ionosphere Research Lab.). Aug. 30, 1966. 57p. (NASA-CR-78913). CFSTI.

A method is developed for the determination of mean ionospheric height by analysing radio signals from a beacon satellite. Two major effects of the ionosphere on the received signals, Faraday rotation and doppler dispersion, are measured. By searching for their consistency and using height dependence of the Earth's magnetic field, it becomes possible to calculate mean ionospheric height along the focus of satellite directions from the observing station. The method is applied to a number of satellite passes involving both normal and unusual ionospheric conditions and height profiles are developed over a range of about five degrees of latitude. (auth)

31308 (N-66-39709) RECOMBINATION COEFFICIENT OF THE NIGHTTIME F-REGION FROM INCOHERENT SCATTER MEASUREMENTS. Scientific Report No. 279. McCrory, Donald Regis (Pennsylvania State Univ., University Park. Ionosphere Research Lab.). Sept. 9, 1966. 61p. (NASA-CR-78980). CFSTI.

Profiles obtained at the Arecibo Ionospheric Observatory for one summer and one winter night have been used to study the nighttime recombination in the F region. A considerable improvement in the consistency of the results is obtained by the use of the incoherent scatter measurements. It is shown that the summer results compare closely with those obtained previously. It was found that in winter the electron content did not decrease and hence a different method was used to calculate the recombination coefficient than was used for the summer data. On this basis, it was quite difficult to make any conclusions about the seasonal dependence of the recombination coefficient. (auth)

31309 (N-67-14884) CHARACTERISTICS OF THE SOLAR WIND-MAGNETOSPHERE TRANSITION REGION. APPENDIX A. Scarf, Frederick L. (TRW Systems, Redondo Beach, Calif. Space Sciences Lab.). Sept. 15, 1966. Contract NASw-1366. 12p. (NASA-CR-80950). CFSTI.

The concept of a collisionless shock transition between the magnetosphere and the free streaming solar wind was originally introduced on the grounds that the interplanetary magnetic field would, somehow, bind the collisionless plasma into a conventional fluid. Details of the dissipation mechanisms were avoided, and aerodynamic analogies were used to compute the location of the shock boundary, assuming that the relevant Mach number is (u/V_A), where u is the wind speed and V_A is the Alfvén wave speed. To an amazing extent, these rough kinematical techniques do provide an accurate statistical prediction for the location of the mean proton boundary, or magnetopause, and the mean shock boundary, or position where the solar wind is first disturbed. However, to a large degree these predictions of the fluid or MHD model are the only ones which appear to have any detailed validity. (auth)

31310 (NASA-CR-689) INVESTIGATION OF PLANETARY IONOSPHERES. Mohr, B.; Poznanski, Z.; Luganski, D.; Kraft, G.; Gross, S. H. (Airborne Instruments Lab., Deer Park, N. Y.). May 1967. Contract NAS 5-9108. 205p.

The study effort was divided into two parts: instrumentation techniques and theoretical analysis. Principal concern was with overall systems evaluation, signal processing, and transmitter design, for an advanced long-range sounder system. Sounding ranges of interest were from nearby to 40,000 km. Application of the new sounder system was made to typical planetary missions such as the Voyager-Mars Orbiter and the Mariner-Mars Fly-By spacecrafts. The theoretical analysis extended the previous effort in which virtual depth characteristics of ionospheric sounding echoes were investigated to include the effects of a planetary magnetic dipole field. The signal-processing design study was based on the previous program, which concluded that digitized pulse-compression and integration techniques were the most desirable methods to be used in advancing the state of the art of ionospheric sounding. Investigations of these techniques and their applications to typical planetary sounding systems resulted in very detailed examinations of circuits, components, and characteristics. The nature of this design effort was directed toward providing a sounding capability from extremely long ranges, as well as from nearby, over a wide band of frequencies, 0.1 to 20.0 MHz. The transmitter design consisted mainly of breadboarding efforts to realize a wide-band untuned system entirely of solid-state components. Desired power levels were based on the previous study and the design achieved the required goal in the main. The task also included a study of the design of matching networks for dipole antennas. (auth)

31311 (NP-16799) IONOSPHERIC RESEARCH. Thirteenth Quarterly Progress Report, October 1, 1966–December 31, 1966. Webb, H. D. (Illinois Univ., Urbana. Electrical Engineering Research Lab.). Jan. 1967. Contract DA-36-039-AMC-03703(E). 87p.

Moon-reflected signals were received at 150.6 Mc on 30 days for 204 hours of operation and at 413.25 Mc on 29 days for 56 hours of operation. Most of the days were magnetically quiet. There were 2 flares of importance on some of the days. The receiving station may be operated automatically on 150.6 Mc. The ratio of the topside to bottomside ionospheric electron content is being calculated for October 1965 using Ft. Monmouth ionograms and lunar reflection data. (auth)

31312 TOTAL IONOSPHERIC ELECTRON CONTENT AT HOUGHTON, MICHIGAN. Yeh, K. C.; Rao, N. Narayana (Univ. of Illinois, Urbana). Can. J. Phys., 45: 1959-62(May 1967).

The electron content is obtained by analysis of records of data from satellite 1961 Omicron I by methods previously used on data taken at Urbana, Illinois. Midday electron content values at different latitudes are compared for 1962 and 1963. (M.H.R.)

31313 ROCKET OBSERVATIONS OF ELECTRON PITCH-ANGLE DISTRIBUTIONS DURING AURORAL SUBSTORMS. McDiarmid, I. B.; Budzinski, E. E.; Whalen, B. A.; Sckopke, N. (National Research Council, Ottawa). Can. J. Phys., 45: 1755-69(May 1967). (NRC-9451).

Electron angular distributions obtained from three rocket flights during auroral substorms are described. Pitch-angle distributions of the incident electrons vary from isotropic to strongly peaked at pitch angles near 90°. Isotropic distributions are sometimes maintained for times at least of the order of minutes with very little change in intensity. When an anisotropic distribution persists for some time, the particle intensity is usually observed to decay. Following an intensity increase the angular distribution generally becomes more isotropic. The degree of isotropy attained following an intensity increase does not appear to depend on the magnitude of the increase but rather on the degree of isotropy before the increase. The intensity of upward moving electrons (pitch angles 90 to 180°) can in most cases be accounted for by atmospheric scattering and mirroring in the undisturbed geomagnetic field. A few cases are observed in which the electron intensity in the pitch-angle range 90 to 180° is probably larger than can be accounted for by normal scattering and mirroring. The effect of an ionospheric current on the intensity of upward moving electrons is considered. (auth)

31314 STUDY OF THE PROTON COMPONENT OF THE INNER RADIATION BELT IN THE BRAZILIAN ANOMALY BY ARTIFICIAL EARTH SATELLITES PROTON-1 AND PROTON-2. Volodichev, N. N.; Nesterov, V. E.; Savenko, I. A.; Sharvina, K. N. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1768-70(Nov. 1966). (In Russian).

The distribution of geomagnetically trapped protons with $E_p >$ 100 MeV above the Brazilian anomaly was studied by the Proton-1 and Proton-2 satellites which repeatedly passed over that region at an altitude of 500 km. Since electrons with energies greater than 20 MeV are practically nonexistent in the inner radiation belt above the Brazilian anomaly it could be assumed that only high-energy protons were registered by the SEZ-1 apparatus, which consisted of a Cherenkov counter placed between two scintillation counters which could detect protons with $E_p > 100$ MeV and electrons with $E_p > 20$ MeV. A similar equipment arrangement was used to detect the flux comprised of protons with $E_p >$ 400 MeV. The geometric factor of the equipment was 133 cm^2 sterad. Information from the counters was partially processed on-board and the results were sent to Earth once every 9 seconds. Preliminary data analysis shows that the proton concentration intensity varied with a period of a few tens of seconds which may have been caused by the satellite's spin about its own axis changing the pitch angle between the measuring apparatus and the anomaly. Proton intensity however may be obtained from the envelope of a curve giving the count rate variation. While the Proton-1 satellite could not register protons with $E_p > 100$ MeV, the Proton-2 could register both those with $E_p > 100$ MeV and those with $E_p > 400$-MeV protons. Judging from the average of three orbits, the ratio of concentrations of protons with $E_p > 100$ MeV and protons with $E_p > 400$ MeV varies from 18 ± 0.5 to 8.5 ± 0.2. The total measurement time for these results was 4 minutes. It is proposed that in the future the proton spectrum be measured as a function of coordinates B and L. (ATD)

31315 BEHAVIOR OF OUTER RADIATION BELT ACCORDING TO DATA FROM ELEKTRON-1 AND ELEKTRON-2 SATELLITES. Kuznetsov, S. N. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1827-9(Nov. 1966). (In Russian).

The K_p index was used to study the interrelationship between the Earth's magnetic field and the variation of parameters associated with the outer radiation belt. The flux due to electrons with $40 \text{ keV} \leq E_e \leq 1.6$ MeV in the equatorial plane was studied as a function of the K_p index by using the Elektron-1 and Elektron-2 satellites. Indirect measurement of the electron flux was made by measuring the bremsstrahlung with gas discharge counters. Analysis of satellite data shows that in the outer radiation belt maximum during periods of relatively quiet magnetic activity the average magnetic flux ($E_e \approx 100$ to 250 keV) decreases with the increasing K_p. The average flux due to electrons with $E_e > 36$ keV does not vary when K_p increases. The boundary of the outer radiation belt was also studied as a function of K_p, and it was established that this boundary shifts to lower values of L when K_p increases. The variation of the outer radiation belt boundary as a function of magnetic disturbance H_{st} is given. Comparison of variation of the belt boundary and the intensity of electrons with different energies in the radiation belt maximum shows that the most abrupt changes in these parameters are accompanied by anomalous attenuation of cosmic noise in the auroral zones. (ATD)

31316 PROPAGATION OF VLF WAVES BELOW AN ANISOTROPIC STRATIFIED IONOSPHERE WITH A TRANSVERSE STATIC MAGNETIC FIELD. Galejs, Janis (Sylvania Electric Products, Inc., Waltham, Mass.). Radio Sci., 2: 557-74(June 1967).

The surface impedance of a cylindrically stratified anisotropic ionosphere has been computed in the presence of a transverse static magnetic field without requiring explicit representations of the individual cylindrical wave functions in the lower ionospheric layers. The propagation parameters are determined from the usual transcendental modal equation which is solved starting out with an initial real solution dependent on the reactive part of the ionospheric surface impedance. The surface impedance computations are continued below the ionospheric boundary height, and the impedance reflected to the ground level by the ionosphere is compared with the ground impedance. The accuracy of the computations is shown to be comparable to a few percent uncertainty of the ground impedance for low conductivity ground. The propagation parameters of the first three waveguide modes are calculated for a number of ionosphere models which include the recent D-region models of Deeks (1966). For propagation in the east-to-west direction, the phase velocity of the second mode is shown to be discontinuous when the real part of the ionospheric reflection coefficient undergoes a sign change. This condition is characterized by an absorption peak and for ionosphere models of lower anisotropy (lower values of ω_H/ν, where ω_H is the gyrofrequency and ν is the effective collision frequency) the interference distance D of the two lowest modes is increased for propagation in the east-to-west direction relative to the west-to-east direction, but it is decreased for larger ω_H/ν ratios which are representative of available models of stratified ionosphere. (auth)

31317 AURORAL ZONE COSMIC NOISE ABSORPTION PULSATIONS. Reid, J. (Univ. of Tasmania, Australia). Nature, 214: 1321-2(June 24, 1967).

Pulsations were observed in cosmic noise absorption at Macquarie Island (54.5°S, 158.95°E), lasting for 5 to 20 sec. and extending to 0.4 dB. They were usually nonsinusoidal and nonperiodic, and occurred in trains over 20 min. to 2 hr. near local midnight. The pulsations were recorded with a riometer having a bandwidth of 2 Mc at 30 Mc centre frequency. The output from the instrument was recorded on a pen recorder, and was also used to frequency modulate a 1000-cps tone recorded on magnetic tape. With this system it was possible to resolve pulses of 140 msec. and 0.2 dB peak to peak amplitude. The pulsations were always accompanied by micropulsations of the pi 2 type. A typical train and its accompanying micropulsations is reproduced. The train type pulsations were all of similar shape, with linear onset and exponential decay. The onset rate was 0.05 dB/sec. and the decay time constant about 8 sec. In addition to the train pulsations there were some of which occurred singly or in groups of two or three, showing a much longer decay time and unaccompanied by significant micropulsation. The train type pulsations strongly resembled the fast bremmstrahlung x-ray pulsations observed with balloons. They were not always associated with aurora. It appears likely that these pulsations have a common cause, such as precipitation of energetic electrons at the top of the atmosphere. (UK)

31318 FREQUENCY SHIFTS ON WHISTLER MODE SIGNALS FROM A STABILIZED VLF TRANSMITTER. McNeill, F. A. (Physics and Engineering Lab., Lower Hutt, New Zealand). Radio Sci., 2: 589-94(June 1967).

VLF signals received in New Zealand from NPG, Seattle, via the whistler mode are usually shifted in frequency during transit. They traverse a region of the magnetosphere which is bounded approximately by the magnetic longitudes of transmitter and receiver and which may vary in latitude during a single night over a range of several degrees. In general, signals are detected only when entry and exit points of the appropriate field lines are in darkness. They are subject to a form of geomagnetic control. The roles of ionosphere and magnetosphere as frequency shifting devices are examined, and it is concluded that the chief agency is an equatorward movement of preferred paths during the night. (auth)

31319 TRANSMISSION OF VLF RADIO WAVES THROUGH THE IONOSPHERE. Wieder, Bernard (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Calif.). Radio Sci., 2: 595-605(June 1967).

The fields of 10-kHz radio waves propagating into and through

the lower ionosphere are calculated by numerical methods, and the attenuation, polarization, and power flow characteristics are examined as a function of height for daytime and nighttime ionospheric electron density profiles with varying angles of incidence, directions of propagation relative to the earth's magnetic field, and dip angle. The conclusions are that virtually all the attenuation of the wave occurs in the lower D region of the ionosphere, that the transmitted wave is nearly circularly polarized, and that the energy of the transmitted wave is traveling nearly along the magnetic lines of force in agreement with the predictions of "ray theory." The analysis also shows the strong variation in transmission with dip angle and with change from day to night ionosphere in agreement with observed variations in intensity and in frequency of occurrence of "whistlers." (auth)

31320 SOLAR FLARE EFFECTS AND VLF RADIO WAVE OBSERVATIONS OF THE LOWER IONOSPHERE. Burgess, B. (Royal Aircraft Establishment, Farnborough, Eng.); Jones, T. B. Radio Sci., 2: 619-26(June 1967).

The observed changes of phase and signal amplitude of vlf radio waves, propagated over distances varying between 1,000 and 10,000 km, which accompany solar flares were studied for the period 1961 to 1964. In general, the phase of the received signal advances and the signal amplitude increases during the onset of a solar flare. However, observations of the GBR transmissions at Rome (1,500-km path) show that for this particular path the phase of the received signal retards in contrast to all other paths studied. Assuming that the conductivity of the lower ionosphere varies exponentially with height under both quiet and disturbed conditions, it is possible to evaluate the waveguide mode characteristics of vlf propagation over large distances. Using this theoretical approach it was shown that the observations can only be interpreted if both the D-region electron density profile is lowered and the gradient of ionization density increased. The magnitude of the flare-produced changes in ionization density profiles of the lower ionosphere was evaluated analytically from solar x-ray data. These profile changes are consistent with the lowering of the D region and increase in ionization gradient that are required to explain the vlf radio wave observations. (auth)

31321 OBLIQUE INCIDENCE IONOSPHERIC REFLECTIONS OF 100 kHz PULSES. Doherty, Robert H. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). Radio Sci., 2: 645-51(June 1967).

The results of a 16-month study of the phase and amplitude variations of 100-kHz Loran-C pulse signals between Attu and Sitkinak in the Aleutian Islands are presented. The data show changes in signal amplitude which occur at the same solar zenith angle throughout the year and phase changes which do not occur at the same solar zenith angle throughout the year. Signal amplitudes averaged 15 dB higher during the night than during the day. The shape of the measured diurnal phase and amplitude changes supports a two-layer formation of the lower ionosphere, the lower layer primarily influencing the signal amplitude, and the other primarily influencing the signal phase. The data suggest that an amplitude change occurs at a solar zenith angle of 100°. This effect occurs while the sun's rays reaching the ionosphere are still penetrating the ozone layer. (auth)

31322 A NOTE ON THE REFLECTION COEFFICIENT OF A SHARPLY BOUNDED IONOSPHERE FOR VLF SIGNALS AT THE MAGNETIC EQUATOR. de Lisle, J. M. (Physics and Engineering Lab., Lower Hutt, New Zealand). Radio Sci., 2: 653-7(June 1967).

Closed formulas for the reflection coefficients of a sharply bounded ionosphere for plane waves incident from any direction at the magnetic equator are derived. (auth)

31323 F REGION AND MAGNETOSPHERE, BACKSCATTER RESULTS. Gordon, Wm. E. (Rice Univ., Houston, Tex.). Rev. Geophys., 5: 191-205(May 1967).

The F region and the magnetosphere are under regular observation by the incoherent-backscatter radar technique at three stations near 70°W longitude and ranging in magnetic latitude from the equator (Jicamarca, Peru), through 30°N (Arecibo, Puerto Rico), to 55°N (Millstone Hill, Massachusetts), and three other stations: Prince Albert in Canada, Nancay in France, and Malvern in England. The total power backscattered from the electrons in a pulse volume at a particular height is related to the number of electrons in the volume when corrected for two factors, each of which usually does not exceed 2. The corrections provide for the lack of equilibrium in the electron and ion temperatures and for the ratio of the Debye shielding distance to the operating wavelength. The corrections can be deduced from a spectral analysis of the returned signal. Alternately, and particularly in the F region, the electron density is determined by observing the differential Faraday rotation of the polarization of the signal, or, under certain conditions by measuring the weak spectral line at the electronic plasma frequency. The total scattered power can be considered to arise from two components: one component having a frequency spectrum spread around the transmitted frequency in a band corresponding to, and produced by, the electronic thermal motions, and the second component having a frequency spectrum spread around the transmitted frequency in a band corresponding to, and produced by, the ionic thermal motion. For all of the operating observatories, the conditions are such that the ionic component dominates in the F region and lower magnetosphere, and, since ionic thermal motion depends not only on the ion temperature but also on the ion mass, it is possible to identify the dominant ion and the ionic composition where mixtures are present. The ionic thermal motion fixes the characteristic width of the spectrum, but the shape of the central region of the spectrum is largely due to the ratio of the electron to ion temperatures. Hence from spectra at various heights it is possible to deduce electron temperature, ion temperature, and ionic composition all as functions of height. Electron density profiles show values of 0.5×10^4 cm^{-3} at 10,000 km (daytime, Jicamarca) and of 5×10^4 and 1×10^4 at 1000 km (daytime and night, Jicamarca). The ion temperature during the day increases from about 1000 degrees near the F peak to a few thousand degrees at about 800 km and remains isothermal to the limits of the observation (usually less than 1500 km). At night the values are about one-half these values. The dominant ion in the F region is O^+, changing to H^+ at about 1000 km during the day and at about 700 km at night. Traveling ionospheric disturbances having a wave structure were observed at heights ranging from 150 km to the limit of observation (about 800 km) and are associated with predictable magnetic storms. They are interpreted in terms of gravity waves on the interface of the cool lower F region and warmer magnetosphere. (auth)

31324 A METHOD FOR THE EXPERIMENTAL DETERMINATION OF THE PARAMETERS OF EQUILIBRIUM IN THE F LAYER OF THE DIURNAL IONOSPHERE. Vasseur, Guy; Bousquet, Claude (Centre National d'Etudes des Telecommunications, Issy-les-Moulineaux, France). Compt. Rend., Ser. A and B, 264: 1036-9(Apr. 3, 1967). (In French).

A determination of the chemical recombination parameters in the F layer of the diurnal ionosphere beginning with electron density profiles deduced from downward ionograms uses also the experimental density profiles, the recent model of concentration of the neutral atmosphere, and ultraviolet solar flux. The values thus found are in agreement with those cited by various authors or deduced from a solar eclipse. This method permits the study of the diurnal variations and of the influence of the temperature. (tr-auth)

31325 SYSTEMATIC DIURNAL VARIATIONS IN THE PERIOD AND POLARIZATION OF MAGNETIC MICROPULSATIONS IN SOUTH-WEST ENGLAND. Nwaigwe, C. N.; Hall, S. H.; Usher, M. J. (Imperial Coll. of Science and Tech., London). Nature, 214: 1319-21(June 24, 1967).

Geomagnetic micropulsations are considered to provide indirect evidence of the existence of hydromagnetic waves generated at the magnetosphere boundary and propagated towards the Earth as Alfvén waves. Predictions have been made, based on theoretical considerations, regarding the dependence of the period of these waves on latitude and on their state of polarisation. There is no general agreement, however, that this latitude dependence exists, and insufficient work has been done, as yet, on the polarisation of these waves to warrant a comparison between theory and observation. Micropulsations of the pc 3, pc 4, and pi 2 (periods 10 to 150 sec.) types were detected in the rate of change of magnetic field in the vicinity of Hartland Point, Devon. An analysis of the diurnal characteristics of these micropulsations is reported. Variation of the period of the predominant pulsation with time of day is depicted graphically. The form of the diurnal variation of the preferred period during daytime was different from that at night. During the night relatively rapid changes occur, decreasing from 80 sec at midnight to 40 sec at 0400 hr. Relatively small changes occur during the daytime, with a preferred period of 30 to 40 sec. Such a diurnal variation is at variance with theoretical deductions. The time of day ratio of the magnetic E–W component (Y) to the N–S component (X) is also shown graphically. There is a tendency for equality in amplitude in the central night hours, but rapid changes during daylight hours, particularly in the forenoon period 1000 to 1200 hr. In a further graph the ratio of the hourly mean amplitudes of pulsations in X and Y are plotted against G.M.T. Rapid forenoon polarisation changes are apparent, together with afternoon dominance in the X component. Analysis of magnetograms in 1965 suggested that the plane of polarisation undergoes a diurnal variation. One of the aims of the study was to verify this conclusion. The diurnal character of period and polarisation may explain why the results of different observers do not lead to a generalized form of the dependence of period on latitude. (UK)

31326 INFRASONIC WAVES AND AURORAL ACTIVITY. Wilson, Charles R.; Nichparenko, Sue (Univ. of Alaska, College). Nature, 214: 1299-1302(June 24, 1967).

The association of infrasonic waves in the atmosphere with auroral and magnetic activity is well recognized. Observations within the northern auroral zone suggest that the occurrence and the characteristics of most of the infrasonic disturbances associated with aurorae can be accounted for by the supersonic movement of large scale auroral forms. (auth)

31327 COLLISIONLESS SHOCK WAVES IN HIGH β PLASMAS. 2. Kennel, C. F.; Sagdeev, R. Z. (IAEA, Trieste, Italy). J. Geophys. Res., 72: 3327-41(July 1, 1967).

Finite cyclotron radius effects create dispersion for magnetosonic waves that propagate perpendicular to the magnetic field in high β plasmas. A solitary wave, and with some dissipation a wave-train-type irreversible shock, can then be constructed in the approximation of low Mach number. Such nonlinear magnetosonic waves are unstable to decay into two others, thus providing dissipation and a thinner shock than for parallel propagating shocks. Since magnetic sound waves couple nonlinearity, the decay length of the turbulence behind perpendicular shocks could be significantly shorter than that behind parallel shocks for which strictly linear Alfvén waves provide the dissipation. (auth)

31328 COLLISIONLESS SHOCK WAVES IN HIGH β PLASMAS. 1. Kennel, C. F.; Sagdeev, R. Z. (IAEA, Trieste, Italy). J. Geophys. Res., 72: 3303-26(July 1, 1967).

Large-amplitude compressional waves propagating along the magnetic field direction necessarily destabilize Alfvén waves in high β plasmas by the firehose mechanism. When the electron temperature is much larger than the ion temperature, a closed set of fluid equations, including the turbulent Alfvén wave dissipation in the quasi-linear approximation, may be constructed. This set, investigated here in the limit of weak shocks propagating along the magnetic field, has shock solutions. Microscopic short wavelength turbulence may also be generated in large-amplitude shocks, but will probably not affect the Alfvén wave spectrum. The existence of large-amplitude and yet-persisting-magnetic field turbulence behind the earth's bow shock is in qualitative agreement with this model. (auth)

31329 STRUCTURE AND DECAY OF THE STARFISH RADIATION BELT, OCTOBER 1963 TO DECEMBER 1965. Beall, D. S. (Johns Hopkins Univ., Silver Spring, Md.); Bostrom, C. O.; Williams, D. J. J. Geophys. Res., 72: 3403-24(July 1, 1967).

Results are presented describing the spatial and temporal characteristics of the artificial radiation zone for a 27-month period extending from October 1963 through December 1965. Data for this study were obtained from instruments aboard the low-altitude, polar-orbiting satellite 1963 38C. Directional fluxes of mirroring electrons of energies $E \geq 0.28$, ≥ 1.2, and ≥ 2.4 MeV are presented for $1.23 \leq L \leq 1.60$ and $0.16 \leq B \leq 0.23$. The time and L dependence of the spectral parameters characterizing the electron population are presented. The spectrum is found definitely to soften as L increases and probably to soften with time; electron mean lifetimes obtained over the entire period show high-energy electrons decaying slightly faster than low-energy electrons. The data show evidence of a substantial increase in the intensity of trapped electrons $E < 1.2$ MeV between October 1963 and March 1964 in the region $1.4 \lesssim L \lesssim 1.8$. A comparison of results with theoretical expectations and with available experimental data is also presented. (auth)

31330 ELECTRON TEMPERATURE AND ION COMPOSITION IN THE F1 REGION. Evans, J. V. (Massachusetts Inst. of Tech., Lexington). J. Geophys. Res., 72: 3343-55(July 1, 1967).

By employing a radar system operating at 23-cm wavelength with the beam directed obliquely, it has been possible to obtain Thomson scatter echoes from the ionosphere in the height range 100 to 300 km that are free from "ground clutter" contamination. The measurements obtained with this system therefore supplement earlier results obtained using the Millstone Hill ionospheric radar, which has a vertically directed beam, and make it possible to obtain the electron and ion temperature distribution over the entire height interval 130 to 800 km approximately. The interpretation of the signal spectrums obtained with the oblique incidence radar requires that an assumption be made about the temperature of either the electrons or the ions, or about the ion composition. In the analysis presented here of the 1964 measurements it was assumed that the ion and neutral temperatures are the same up to a height of about 250 km and that only O^+ ions prevail at this height. Thus the ion temperature could be determined for 250-km altitude, and its dependence for lower heights was assumed to follow the same exponential law as in the CIRA 1965 model atmosphere. It was then possible to determine the electron temperature and the ratio of (O^+) to $(O_2^+ + NO^+)$ ions in the height range 135 to 250 km. These results are presented and compared with rocket determinations. (auth)

31331 DISCONTINUITIES IN THE SOLAR WIND ASSOCIATED WITH SUDDEN GEOMAGNETIC IMPULSES AND STORM COMMENCEMENTS. Gosling, J. T.; Asbridge, J. R.; Bame, S. J.; Hundhausen, A. J.; Strong, I. B. (Los Alamos Scientific Lab., N. Mex.). J. Geophys. Res., 72: 3357-63(July 1, 1967). (LA-DC-8649).

Sudden changes in the momentum flux of the interplanetary solar wind at the time of geomagnetic sudden storm commencements and sudden impulses have been observed with hemispherical electrostatic analyzers aboard the twin Vela 2 satellites. It has often been suggested that a sudden storm commencement or impulse necessarily implies the existence of a shock wave propagating in the solar wind. However, present measurements suggest that many such events are the result of tangential discontinuities in the solar wind. (auth)

31332 ION TEMPERATURE IN THE UPPER ATMOSPHERE. Banks, Peter M. (Univ. of California, San Diego, La Jolla). J. Geophys. Res., 72: 3365-85(July 1, 1967).

The problem of ion temperature in the ionosphere is analyzed in terms of an energy budget that includes heating by the ambient electron gas, cooling by the different gases of the neutral atmosphere, and thermal conduction along the lines of geomagnetic force. With the introduction of the ion temperature fractional separation X, the time-dependent equation for ion temperature excluding transport effects is reduced to a form that removes the explicit dependence upon the neutral gas temperature and separates the effects of the electron and neutral gases. Adopting the appropriate aeronomic conditions, it is shown with different models of the neutral atmosphere that the ion temperature has a transitional behavior, increasing from the neutral gas temperature near 250 km toward the electron temperature above 700 km. While the ion thermal transport does not significantly affect ion temperatures below about 500 km at midgeomagnetic latitudes, it plays an increasingly important role above this height, acting to keep the high-altitude ion temperature significantly less than the electron temperature. In addition, as a result of ion cooling in He and H, the ion temperature can decrease with altitude in the transition atmospheric regions between O and H dominance. The time constant for changes in ion temperature resulting from changes in aeronomic parameters is evaluated and found to be less than 10 minutes for altitudes below 700 km; above this altitude, conduction cooling must be considered. Finally, the theoretical expressions derived here are compared with recent ionospheric Thomson scatter data. (auth)

31333 AN UPPER LIMIT ON THE QUIET TIME SOLAR NEUTRON FLUX AT ENERGIES >60 MeV. Webber, W. R.; Ormes, J. F. (Univ. of Minnesota, Minneapolis). J. Geophys. Res., 72: 3387-94(July 1, 1967).

During the course of a series of balloon flights with Čerenkov scintillation counters designed to measure the energy spectrum of charged primary cosmic-ray nuclei, it has been possible to set limits on the quiet-time solar emission of neutrons in the energy range above 60 MeV. These limits (which are nearly an order of magnitude smaller than previously reported), were obtained by comparing the intensity of secondary protons at ≈ 12 g/cm^2 atmospheric depth near the equator as measured on two balloon flights, one with the detector telescope oriented vertically and the other with the detector telescope oriented at a zenith angle of $\approx 50°$ and rotating in azimuth. This latter telescope alternately pointed at the sun and at an angle 90° to the sun. The absence of any excess secondary proton flux when the detector was pointing at the sun allows us to set a 2 σ limit of <1.0 protons/m^2 ster sec in the energy range 60–320 MeV as being produced in the atmosphere above the detector by solar neutrons. Considering the efficiency of proton production by neutrons in ≈ 12 g/cm^2 of air we are able to set an upper limit of 24 solar neutrons/m^2 sec >100 MeV, assuming a differential neutron spectrum at the earth $\approx E^{-2}$. Further details on the limits of solar neutrons in various differential energy intervals are presented, and these results are compared with other observations. (auth)

31334 LOW ATTENUATION OF HYDROMAGNETIC WAVES IN THE IONOSPHERE AND IMPLIED CHARACTERISTICS IN THE MAGNETOSPHERE FOR PC 1 EVENTS. Campbell, Wallace H. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). J. Geophys. Res., 72: 3429-45(July 1, 1967).

Studies of natural hydromagnetic emissions at 0.5 and 1.0 cps, called pc 1, detached at the conjugately located stations of Baie St. Paul (Quebec), Canada, and Eights Station, Antarctica, indicate an ionospheric attenuation of the signals. In transmission through the daytime ionosphere at 47°N latitude, during the 1964 summer, the signals seem to be reduced to about 0.5–0.7 (at 0.5 cps) and 0.2–0.5 (at 1.0 cps) of their original amplitudes.

The higher values corresponded to $K_p < 2$ and the lower values to K_p of about 3. If some minor assumptions are made concerning the nature of the wave coupling, the measured attenuations appear to be close to predicted values. The magnitudes of energy absorption indicate that significant ionospheric heating does not occur. World station observations, when appropriately translated into the magnetosphere, implied (1) a particle distribution, rather uniform between L values of 7 and 4 with extremal magnitudes in the afternoon and predawn side and (2) a hydromagnetic wave excitation region varying from the noon side at L = 7 to the early morning side at L = 4. (auth)

31335 GENERATION OF TURBULENCE IN THE UPPER ATMOSPHERE BY INTERNAL GRAVITY WAVES. Hodges, R. R. Jr. (Southwest Center for Advanced Studies, Dallas). J. Geophys. Res., 72: 3455-8(July 1, 1967).

If turbulence is a produced, rather than intrinsic, property of the upper atmosphere, then it is necessary to identify mechanisms that can create turbulence in an initially quiescent region of the atmosphere. Wind shears of sufficient magnitude to do this have a very slight probability of occurrence. However, the density fluctuations that must accompany internal gravity waves must often be of sufficient amplitude to produce convective instabilities in thin layers that propagate with the waves. This is suggested as an important mechanism for the production of turbulence in an initially quiescent region of the upper atmosphere. (auth)

31336 INTERPLANETARY MAGNETIC FIELD DATA AND CORRESPONDING GEOMAGNETIC EFFECTS FOR THE STORM OF OCTOBER 7, 1962. Zelwer, R.; Fernando, P. C. B.; Ward, S. H. (Univ. of California, Berkeley). J. Geophys. Res., 72: 3471-82(July 1, 1967).

Interplanetary magnetic fields and bulk plasma velocity values gathered by the Mariner 2 spaceprobe and corresponding to the recurrent geomagnetic storm of October 7, 1962, have been compared to ground-based standard magnetograms and micropulsation recordings. The results indicate that (1) high-latitude micropulsation enhancements can sometimes be correlated to large changes in interplanetary fields, (2) these sharp changes in the interplanetary fields and their corresponding effects suggest an interplanetary field structure corotating with the sun, a possibility that is consistent with the Pioneer 6 results, and (3) extended periods of micropulsations as well as bay disturbances are preceded and accompanied by exterior fields having a southward component. These results may provide support for Dungey's theory of reconnection between geomagnetic and interplanetary lines of force. (auth)

31337 PRODUCTION OF IONIZATION BY MICROMETEORITES. Fiocco, Giorgio (Massachusetts Inst. of Tech., Cambridge. Smithsonian Astrophysical Observatory, Cambridge, Mass.). J. Geophys. Res., 72: 3497-3501(July 1, 1967).

The large influx of micrometeorites in the earth's atmosphere may be responsible for the production of ionization in amounts comparable to those needed in the E region at night and in some types of sporadic-E irregularities. The problem is reconsidered, and the ionization resulting from neutral–neutral collisions of the ambient gas induced by the meteoroid is calculated. (auth)

31338 COHERENCY OF X-RAY AND OPTICAL PULSATIONS IN AURORAS. Rosenberg, T. J. (Univ. of Bergen); Bjordal, J.; Kvifte, G. J. J. Geophys. Res., 72: 3504-6(July 1, 1967).

Some results are presented of an experiment that strongly suggest that quasi-periodic x-ray and optical pulsations of durations of several seconds are coherent. Optical and x-ray pulsations recorded by a balloon-borne 5577-A photometer and scintillation counter during a pulsating auroral event are plotted. (J.H.M.)

31339 SATELLITE PROTONS AS A TEST OF SOLAR NEUTRON OBSERVATIONS. Holt, Stephen S. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 72: 3507-10 (July 1, 1967).

The Tata group reported evidence for solar neutrons from balloon-borne nuclear emulsions (Appa Rao et al., 1966), which, up until 1967, has been the only indication of a positive result. Also, the Tata group reported an experiment (Daniel et al., 1967) in which the detection of solar neutrons seems unambiguous. It is pointed out that indirect evidence exists which indicates that solar neutrons were not observed in the experiment, and that any subsequent detection of solar neutrons can be tested by the detection of associated protons on satellites. (J.H.M.)

31340 MOTIONS OF AN ELECTRON–ION CLOUD RELEASED AT 100 KILOMETERS FROM A GUN-LAUNCHED PROJECTILE. Murphy, C. H. (Ballistic Research Labs., Aberdeen Proving Ground, Md.); Bull, G. V.; Wright, J. W. J. Geophys. Res., 72: 3511-14(July 1, 1967).

Data are presented on the motions of a cesium cloud released from an 84-kg projectile. The projectile was launched at a muzzle velocity of 1770 m/sec with a breech pressure of 2.4 kb at 85°. The payload was detonated at an altitude of 100.5 km, 95 seconds after launch. An ionogram taken 120 seconds after launch showed echoes up to the maximum frequency of the ionosonde (10 Mhz). To permit optical measurements of the cloud, a small amount of sodium was placed in the mix, and the shot was so timed that the cloud would be in sunlight. Data on the latitude, longitude, and height of the sodium cloud, versus time, are plotted. (J.H.M.)

31341 A NOTE ON GEOMAGNETIC ACTIVITY AND SPORADIC E. Chowdhury, N.; Guha, D. (Inst. of Radio Physics and Electronics, Calcutta). J. Geophys. Res., 72: 3515-16(July 1, 1967).

Data on the occurrence of sporadic E and magnetic activity at three African zone stations are analyzed. Results indicate that for stations in the latitude range 20 to 30°N, sporadic E occurrence is likely to be independent of magnetic activity. But for stations lying below 20°N latitude, sporadic E occurrence is affected by magnetic activity. (J.H.M.)

31342 SPREAD OF TRAVELLING DISTURBANCES AND THEIR INFLUENCE ON ALTITUDE-FREQUENCY CHARACTERISTICS OF IONOSPHERE. Grigor'ev, G. I. (Scientific-Research Radiophysics Inst., Gorky, USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 10: 466-72(1967). (In Russian).

The distance of nondistorted propagation of travelling disturbances has been estimated. Altitude-frequency characeristics of the ionosphere with a parabolic profile of equilibrium electron concentration in the presence of horizontally propagating wave-like inhomogeneities of plasma were determined. Some relationships have been derived, characterizing spatial distortion of impulses. (auth)

31343 SLOW OSCILLATIONS OF FLUID IN A ROTATING CAVITY IN THE PRESENCE OF A TOROIDAL MAGNETIC FIELD. Stewartson, K. (Univ. Coll., London). Proc. Roy. Soc. (London), Ser. A, 299: 173-87(June 14, 1967).

Hide (1966) suggested that the slow westward drift of the nondipole components of the earth's magnetic field may be caused by slow free oscillations of the fluid part of the earth's core in the presence of a dominant toroidal magnetic field. An attempt is made to analyze this suggestion in detail. First, slow (or second class) oscillations in a thin shell are examined in the presence of a uniform toroidal field, and Hide's theory is shown to be qualitatively correct but to underestimate the actual periods of oscillation. In these oscillations the drift is to the east, and Hide argued that for a thick shell there will be a change of sign in the drift, in conformity with observation. Accordingly the theory is extended to thick shells, but it is shown that, for oscillations in (I-I) correspondence with those already found for a thin shell, no such change of sign occurs. Since such oscillations are as likely to be manifested on the exterior field as any other it is concluded that the analysis presented raises a serious objection to Hide's proposal. It is noted, however, that for some higher modes of oscillation a drift to the west is almost certain. (auth)

31344 HYDROMAGNETIC PLANETARY WAVES. Malkus, Willem V. R. (Univ. of California, Los Angeles). J. Fluid Mech., 28: 793-802(1967).

A study is made of hydromagnetic oscillations in a rotating fluid sphere. The basic state is chosen as a uniform current parallel to the axis of rotation. It is found that the nondissipative normal modes are described by a modified form of the Poincaré eigenvalue problem. For small rotation rates, the lowest nonaxisymmetric modes are unstable. For rotation rates of geophysical interest all normal modes are stable. The introduction of ohmic dissipation leads to a hydromagnetic boundary-layer problem. Solutions for the boundary layer are outlined, indicating its role in altering the free periods, damping the oscillations and producing external magnetic fields. Dispersion relations are derived which establish that the zonal phase velocities of both "fast" hydrodynamic and "slow" hydromagnetic waves can be of either sign. Observations of the secular variations of the earth's magnetic field indicate motion primarily toward the west. A mechanism for the selective excitation of the observed motion is discussed. (auth)

31345 ORIGIN OF SOME DIFFUSE TRACKS OBSERVED BY THE IONOSPHERIC PROBES OF THE ALOUETTE SATELLITE. Dufaux, Jacques (CNET, Issy-les-Moulineaux, France). Compt. Rend., Ser. A and B, 264: 1170-2(Apr. 10, 1967). (In French).

The simultaneous observation of noise bands at low frequency and of diffuse tracks on the ionograms of the Alouette satellite leads to the suggestion of an instability phenomenon of the plasma as an origin of the ionization irregularities. (tr-auth)

31346 LUNAR EFFECT ON THE TOTAL ELECTRON CONTENT OF THE WINTER IONOSPHERE DURING THE SOLAR

ACTIVITY MINIMUM. Bertin, Francois; Papet-Lepine, Jacques (Faculte des Sciences, Paris). Compt. Rend., Ser. A and B, 264: 825-8(Mar. 6, 1967). (In French).

The nocturnal evolution of the total electron content of the ionosphere was studied during the winter months and during the solar activity minimum. A tendency to a pseudo-periodic variation in which the maxima and minima correspond to the full and new moon phases was noted. (tr-auth)

Low-Temperature Physics

Refer also to abstract 30572.

31347 (CONF-661016, pp 116-19) FIELD DEPENDENCE OF THE RATE OF DECAY OF PERSISTENT CURRENTS IN AN Nb-25 PERCENT Zr SUPERCONDUCTING SOLENOID. File, J. (Princeton Univ., N. J. Plasma Physics Lab.).

The study was made with an accurately designed and manufactured sixth-order solenoid of 20-mil-diameter, copper-plated Nb-25%Zr wire. Sophisticated measuring techniques were used. All measurements were made at 4.2°K. The decay rate has been observed at various values of the self induced field. The field has been varied from some 10 G below critical down to about 60% of critical. The data from these runs indicate that over a range of values of B, the logarithm of the decay rate of the field varies linearly with field, B. (M.O.W.)

31348 (CONF-661016, pp 123-6) STABILITY OF SUPERCONDUCTING MAGNETS. Gauster, W. F. (Oak Ridge National Lab., Tenn.).

The performance of liquid-helium-cooled stabilized superconductors was investigated. Stekly's and Zar's theory of the performance of stabilized conductors was analyzed and extended by applying in more detail the concept of "flux flow" and by considering the nonlinear heat transfer to the helium bath. Numerical examples are shown. Investigations concerning non- or slightly stabilized superconductors are discussed. (auth)

31349 (CONF-661016, pp 261-82) SUPERCONDUCTING MAGNET SYSTEMS. Laverick, Charles (Argonne National Lab., Ill.).

Superconductor application to magnet systems is reviewed. The main topics are: magnet materials, composite conductors, magnet systems and coils, temperature effects, radiation effects, cryogenic problems, and magnet and power supply stability. (M.O.W.)

31350 (N-66-30857) DEVELOPMENT OF A LIGHTWEIGHT CRYOGENIC INSULATING SYSTEM. Final Report, June 30, 1964-May 31, 1966. Burkely, R. A.; Kariotis, A. H.; Yoder, F. D.; Apisa, J. N.; Kost, P. (Goodyear Aerospace Corp., Akron, Ohio). May 1966. Contract NAS8-11761. 240p. (NASA-CR-76368; GER-12269). CFSTI.

The primary effort was expended on the development of materials and fabrication techniques associated with 9 dual-seal cryogenic insulation concept. Thermal and structural characteristics of selected panel constructions were defined by liquid hydrogen tankage tests on a large oval-shaped tank. (auth)

31351 (N-67-12913) STUDY OF PROPERTIES OF HIGH-FIELD SUPERCONDUCTORS AT ELEVATED TEMPERATURES. Final Technical Report, April 27-August 26, 1966. Gandolfo, D. A.; Harper, C. M. (Radio Corp. of America, Camden, N. J.). Oct. 7, 1966. Contract NAS8-11272. 33p. (NASA-CR-80154). CFSTI.

Magnetization experiments on specimens of Nb_3Sn, NbTi, and Nb are reported. The Nb_3Sn specimens were pressure sintered, and one of them contained a ferromagnetic inclusion. Values of the critical state parameter, α, as a function of temperature were obtained. The NbTi specimen was cast and cold worked. Values of α and the threshold for ac field-induced flux jumps were obtained before and after a 400°C heat treatment. An improvement in both quantities by a factor of more than 2 was observed. The Nb sample was also cast and cold worked. For H near H_{c2} the supercurrent in this specimen was very stable against ac field-induced flux jumps, while for H somewhat less than H_{c2}, behavior in superimposed ac and dc fields resembled that of NbTi. Recommendations for further effort are given. (auth)

31352 COHERENT RADIATION FROM HIGH-ORDER QUANTUM TRANSITIONS IN SMALL-AREA SUPERCONDUCTING CONTACTS. Zimmerman, J. E.; Silver, A. H. (Ford Motor Co., Dearborn, Mich.). Phys. Rev. Lett., 19: 14-16(July 3, 1967).

A new type of oscillation arising from the coherent motion of large numbers of flux quanta across small-area superconducting contacts is reported. It produces a unique spectrum at the frequency ω_D when $2\pi nV_0 = N\Phi_0\omega_D$, where V_0 is the dc voltage across the contact, n is an integer, $\Phi_0 = h/2e$, and N is the number of flux quanta crossing per cycle. The power dependence varies as N^2 with values of N from 1 to 200 observed. (auth)

31353 EFFECTS OF FREE ENERGY APPROXIMATION ON SUPERCONDUCTING SURFACE SHEATH CALCULATIONS. Bandy, W. R.; Haden, C. R.; Shockley, T. D. (Univ. of Oklahoma, Norman). Phys. Lett., 24A: 711-12(June 19, 1967).

The order parameter of the Ginzburg-Landau theory is calculated for magnetic fields in the nucleation region by using the first four terms in the free energy expansion. The highest order term is shown to be effective well above the bulk critical field, making necessary a more detailed study of its coefficient. (auth)

31354 PAIR CORRELATION OF SUPERCONDUCTIVE TYPE IN POLYCYCLIC MOLECULES. Kresin, V. Z. (Moscow Pedagogical Inst.). Phys. Lett., 24A: 749-50(June 19, 1967).

Pair correlations of electrons in complex molecules are treated like those of nucleons in nuclei. (auth)

31355 DISAPPEARANCE OF THERMAL MAGNETIC FLUCTUATIONS IN A SUPERCONDUCTOR. Vant-Hull, L.; Simpkins, R. A.; Harding, J. T. (Ford Scientific Lab., Newport Beach, Calif.). Phys. Lett., 24A: 736-7(June 19, 1967).

A quantum interference magnetometer has made possible the observation of thermal magnetic noise in conductors below 4.2°K. These fluctuations, which are of order $B^2 = \mu_0 kT$/volume in a normal conductor, decrease by more than an order of magnitude when the specimen becomes superconducting. (auth)

31356 PROXIMITY EFFECTS BETWEEN SUPERCONDUCTORS AND FERROMAGNETIC DOMAINS. Meunier, F.; Burger, J. P.; Deutscher, G.; Van Dalen, P. A. (Univ., Paris, Orsay, France). Phys. Lett., 24A: 722-4(June 19, 1967).

It has been observed that in the vicinity of the critical temperature T_{cSF} of superconducting (Pb) and ferromagnetic (permalloy) SF binary layers, resistive and tunneling effect measurements were sensitive to the magnetic history of the ferromagnetic film. (auth)

31357 MEASUREMENT OF RECOMBINATION LIFETIMES IN SUPERCONDUCTORS. Rothwarf, Allen; Taylor, B. N. (RCA Labs., Princeton, N. J.). Phys. Rev. Lett., 19: 27-30(July 3, 1967).

It is shown that the experimentally measured quasi-particle recombination lifetime in a superconductor is not the same as the previously calculated theoretical lifetime. A simple expression relating the two is derived. (auth)

31358 TEMPERATURE DEPENDENCE OF UPPER CRITICAL FIELDS FOR CLEAN SUPERCONDUCTORS OF THE SECOND KIND. Lueders, Gerhart (Univ., Goettingen, Ger.). Z. Phys., 202: 8-12(1967).

Boundary conditions to a generalized and linearized Ginzburg-Landau equation were recently derived by Schöler for clean superconductors. In this paper they are used for a calculation of the ratio H_{c3}/H_{c2} up to first and second order in $[(T_c - T)/T_c]^{\frac{1}{2}}$. The result depends upon the electron reflection properties of the surface. It differs from a result obtained previously by Ebneth and Tewordt. (auth)

31359 IDEAL RESISTIVITY OF PLATINUM BELOW 20°K. Berry, R. J. (Univ. of Ottawa, National Research Council, Ottawa). Can. J. Phys., 45: 1693-1708(May 1967).

An improved estimate for the electrical resistivity of ideally pure platinum is derived for the 3 to 20°K region from highly accurate measurements on a specimen of thermometric-grade Pt. The two-band model is used to correct for the small, but significant, impurity scattering. The temperature dependency of this "ideal" resistivity function is compared with theory and previous work. Certain discrepancies are noted. (auth)

31360 THE SURFACE TENSION OF LIQUID HELIUM I AND THE LAW OF CORRESPONDING STATES. Devaraj, N.; Hallett, A. C. Hollis (Univ. of Toronto). Can. J. Phys., 45: 2113-20(June 1967).

Measurements have been made by determining the force necessary to break the liquid film between the edge of a suspended metal ring and the liquid surface. The results obtained are about 13% larger than those given by Allen and Misener (1938), and the variation of the surface tension, γ, with temperature T fits quite well the equation $\gamma = 0.600\ (1 - T/T_c)^{1.04}$ dyne cm^{-1}, where T_c is the critical temperature. Comparison with other liquids has been made following de Boer's formulation of the law of corresponding states, and the reduced equation $\gamma^* = (\gamma_0^*/T_c^{*n})(T_c^* - T^*)^n$ describes the results, (γ_0^*/T_c^{*n}) and n being functions of the quantum parameter Λ^*; the classical limit of (γ_0^*/T_c^{*n}) is found by extrapolation to be 2.2. (auth)

31361 AN EXPLANATION OF THE CRITICAL STATE AND THE CONSTRAINED REVERSIBILITY RELATIONS IN HYS-

TERETIC SUPERCONDUCTORS. Schweitzer, D. G. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. Phys. Lett., 24A: 718-19(June 19, 1967). (BNL-11120).

An experiment is described which shows that states on reversible diamagnetic paths in H for $B \neq 0$ as well as $B = 0$ also exist on reversible paths in temperature where the conditions for reversibility are $(dB/dH)_T = (dB/dT)_H = 0$. The result is a thermodynamic confirmation that B has the properties of an independent variable and implies that the Gibbs free energy function for these systems contains a magnetic term analogous to the chemical potential. (auth)

31362 DESTRUCTION OF SUPERCONDUCTING METASTABLE STATES BY β-IRRADIATION. Bernas, H.; Burger, J. P.; Deutscher, G.; Valette, C.; Williamson, S. J. (Univ., Paris, Orsay, France). Phys. Lett., 24A: 721-2(June 19, 1967).

The first observation of a β-ray-stimulated transition between a superheated superconducting state and the normal state is reported. The effectiveness of the radiation upon a superconducting mercury colloid is greatly enhanced at low temperatures and for magnetic fields approaching the superheating field. (auth)

31363 ELECTRODYNAMICS OF NONPURE SUPERCONDUCTORS WITH OVERLAPPING ENERGY ZONES. Kon, L. Z. (Inst. of Mathematics With Computer Center, Kishinev, USSR). Fiz. Metal. Metalloved., 23: 211-19(Feb, 1967). (In Russian).

The Ginzburg–Landau equations are extended for nonpure superconductors with a single energy zone to the case of nonpure superconducting metals with overlapping of energy bands in the neighborhood of the Fermi level at temperatures close to T_{cr}. The coefficients of these equations are calculated for large and small concentrations of the impurity, whether magnetic or nonmagnetic. On this basis, formulas are derived for the thermodynamic critical magnetic field, for the depth of penetration of a weak magnetic field in superconductors, for the ratio of the upper critical magnetic field to the thermodynamic critical magnetic field, and for the difference in specific heat between normal and superconducting phases. The conditions for the existence of nonpure superconductors of type II (with dimensionless constant $\chi > 1/2$) are derived for superconductors with two overlapping energy bands on the basis of an examination of "parasitic" solutions. (ATD)

31364 INDIRECT EXCHANGE INTERACTION IN NORMAL AND SUPERCONDUCTING METALS. Berdyshev, A. A.; Akhtyamov, O. S. (Ural State Univ., Sverdlovsk, USSR. Bashkir State Univ., Ufa, USSR). Fiz. Metal. Metalloved., 23: 220-5(Feb. 1967). (In Russian).

The exchange interaction between the spins of conduction electrons and the spins of localized magnetic ions leads to an effective indirect exchange interaction between the spins of magnetic ions; such an interaction is of an oscillating nature, with the oscillation period being determined by the magnitude of the Fermi wave vector p_s. In this connection, indirect exchange interaction between extrinsic magnetic moments in both normal and superconducting ferromagnetics is considered on the assumption that conduction electrons are spin-polarized. It is shown that, by contrast with the paramagnetic phase, the longitudinal and transverse parts of exchange interaction in a normal ferromagnetic markedly differ from one another and each such part splits into two groups of terms with different oscillation periods. Indirect exchange in a superconducting ferromagnetic virtually does not differ from the exchange in the paramagnetic phase of superconductors. (ATD)

31365 INTERNAL PHENOMENA IN A SUPERCONDUCTING COIL. Iwamoto, M.; Kaneseki, N. (Mitsubishi Electric Corp., Japan). Elec. Eng. Jap. (Engl. Transl.), 86: 14-21(May 1966).

When a superconducting coil undergoes the S–N transition, some abnormal phenomena are observed due to the sudden emission of magnetic energy. For example, an abnormal voltage caused by the S–N transition may cause a dielectric breakdown of the specimen. Also, because of the excessive heating of the specimen, it may be annealed. To prevent this damage to the specimen, the nature of the abnormal phenomena within the coil must be ascertained. Some results concerning these abnormal internal phenomena, obtained with a superconducting coil made with 2 superconducting wires (Nb–25% Zr, dia 0.254 mm, insulation covered, no Cu shielding) and an insulated Cu wire, are reported. During the magnetic excitation, at each excitation a flux jumping phenomenon characteristic of each excitation process was observed. This flux jumping could be explained in terms of the magnetization characteristic and the internal field distribution of the superconductor. Premonitory pulses were always observed immediately before the S–N transition. This is an important phenomenon in the operation of a superconducting coil. The relation between the coil current and the flux distribution inside the superconductor was considered theoretically. The theoretically calculated current value for the threshold flux distribution agreed well with the experimentally measured value of S–N transition current. (BBB)

31366 FLUX FLOW RESISTIVITY IN TYPE-II SUPERCONDUCTORS. II. THEORETICAL DISCUSSION. Vinen, W. F.; Warren, A. C. (Univ. of Birmingham, Eng.). Proc. Phys. Soc. (London), 91: 409-21(June 1967).

Existing theories of flux flow resistivity in type-II superconductors are reviewed, and an extension of the work of Nozières and Vinen [Phil. Mag., 14: 667-88(1966)] is introduced, in which the motion of a flux line is related to certain relaxation times governing the rate of change of the superconducting order parameter. The various experimental results on flux line motion are compared with this extended theory. (auth)

31367 FLUX FLOW RESISTIVITY IN TYPE-II SUPERCONDUCTORS. I. EXPERIMENTAL RESULTS. Vinen, W. F.; Warren, A. C. (Univ. of Birmingham, Eng.). Proc. Phys. Soc. (London), 91: 399-408(June 1967).

Observations are reported of the rate at which flux enters or leaves various specimens of type-II superconductors when the applied magnetic field is suddenly changed, and the results are used to deduce values of the flux flow resistivity. It is shown that Kim's empirical relation for this resistivity is obeyed both in Nb–Ta alloys ($l < \xi$) and in pure niobium ($l \gg \xi$). Some account of the observed magnetization curves in the specimens is also included. (auth)

31368 ON THE PROBLEMS OF MEASURING TRANSIENT TEMPERATURE IN CRYOGENIC FLUIDS. Miller, C. E.; Flynn, T. M. (National Bureau of Standards, Boulder, Colo.). ISA (Instrum. Soc. Amer.), Trans., 6: 133-8(Apr. 1967).

The complex and frequently unpredictable energy exchange mechanisms that govern the dynamic behavior of cryogenic sensors make the measurement of transient temperatures extremely difficult. Without suitable models by which to predict and evaluate sensor performance, considerable measurement errors can and do occur. Those factors which give rise to these errors are delineated in detail. The validity of using notions based on the performance of the "ideal" thermometer for characterizing the cryogenic case is also discussed. (auth)

31369 WAVE MOTIONS IN ROTATING HELIUM II. Snyder, H. A.; Westervelt, P. J. (Brown Univ., Providence). Ann. Phys. (N.Y.), 43: 158-94(June 2, 1967).

A general account is given of wave propagation in uniformly rotating He II. A formal solution is presented for the four types of waves which occur in the interior of the fluid: first sound, second sound, inertial waves, and vortex waves. Boundary-layer solutions are not considered in detail. Several special cases are solved to illustrate the mechanics and to gage the magnitude of small effects. The results are applicable to ordinary fluids as well as to He II. (auth)

31370 THREE-OPERATOR GREEN'S FUNCTIONS FOR THE SUPERFLUID BOSE-SYSTEMS. Galasiewicz, Z. (Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 15: 191-6(1967).

Temperature-retarded Green's functions of the type $\langle\langle\psi^+\psi;\psi\rangle\rangle$ for superfluid Bose systems were calculated in the hydrodynamic approximation. It is shown that the two-operator functions obtained have poles for the energies of the quanta of the first and second sound. (R.V.J.)

31371 HYDRODYNAMIC EQUATIONS IN THE THEORY OF SUPERCONDUCTIVITY. Svidzinskii, A. V.; Slyusarev, V. A. (Physical-Technical Inst. of Low Temperatures, Kharkov). Dokl. Akad. Nauk SSSR, 172: 322-5(Jan. 11, 1967). (In Russian).

Equations of two-fluid hydrodynamics for London-type superconductors were derived from the equations of the microscopic theory of superconductivity. The derivation is based on separating the gauge-noninvariant factors of the correlation functions of a nonequilibrium superconductor, and transition to a mixed representation of the correlation functions. This is followed by derivation of equations for the superfluid velocity and for the time evolution of other hydrodynamic quantities in the superconductor. These, together with the continuity equation, and the equations for the energy flux, the current density, and the momentum flux density tensor constitute a complete system of equations of two-fluid hydrodynamics as derived by L. D. Landau, generalized to the case of charged particles. The results agree with those of M. J. Stephen (Phys. Rev. v. 139, A197, 1965), except that Stephen's intermediate expressions are considered to be inconsistent. (ATD)

31372 GAUGE TRANSFORMATION AND GREEN'S FUNCTIONS FOR SUPERFLUID BOSE-SYSTEMS. Galasiewicz, Z. (Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 15: 185-90(1967).

Some connections are derived for the Green's functions in the case of superfluid Bose-systems. These connections are obtained by applying to the Bose operators time dependent and time independent gauge transformations. A part of the results is compared with those which follow from the "hydrodynamic approach" to the Green's function. (W.D.M.)

31373 CLASSICAL THEORY OF THE FEYNMAN–ONSAGER VORTEX. Turski, L. (Inst. of Fundamental Technical Problems, Polish Academy of Sciences). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 15: 197-203(1967).

A new formulation is offered for the classical theory of vortices in superfluid helium and superconductors. A new derivation of the equation of motion for vortices and of the Magnus-type interaction forces is proposed, based on the variation principle and on methods developed in the theory of discrete defects. Interactions of such type forces were formerly postulated in the theory of superfluidity based on the analogy with hydrodynamics. (tr-auth)

31374 CRITICAL CONDUCTION AND INDUCED CURRENTS IN THE SURFACE OF Nb (25 PERCENT) Zr RIBBON AT LOW FIELDS. Chang, C. T. M.; LeBlanc, M. A. R. (Univ. of Southern California, Los Angeles). Appl. Phys. Lett., 10: 344-7 (June 15, 1967).

The level of conduction and induced currents required for the onset of entry or exit of flux in an "infinite" slab of Nb (25%) Zr ribbon cooled through T_c in a static, parallel magnetic field depends on the sense of the currents. A small Meissner effect is observed in this material. It is argued that a net paramagnetic current is induced in the surface layer during cooling through T_c in a static field $H < H_{c2}$. (auth)

31375 HIGH SUPERCONDUCTING TRANSITION TEMPERATURE IN THE MOLYBDENUM CARBIDE FAMILY OF COMPOUNDS. Toth, L. E. (Univ. of Minnesota, Minneapolis). J. Less-Common Metals, 13: 129-31(July 1967).

Superconducting transition temperature measurements are reported for Mo_3GaC and Mo_3BC, both having the Mo_6C octahedral subcell. The midpoints for the transitions occurred at 6.3°K for Mo_3BC and at 3.9°K for Mo_3GaC. (M.O.W.)

31376 RESIDUAL RESISTIVITY AND GROWTH OF THERMOELECTRIC POWER OF METALS AT LOW TEMPERATURES. Leonard, P. (Faculte des Sciences, Strasbourg). J. Phys. (Paris), 28: 328-38(Mar.-Apr. 1967). (In French).

The residual resistivities of metals are calculated using simple models (free electrons, spherically symmetrical potential for the impurity). The use of a square well potential is satisfactory only for monovalent metals, while for polyvalent metals the order of magnitude is obtained with the first order self-consistent Hartree potential of a point charge. The increase of the thermoelectric power associated with the residual resistivity is not accurately explained. A study of phase shifts as a function of energy is given for the Hartree potential. (auth)

31377 CONTRIBUTION TO THE THEORY OF THE TUNNEL EFFECT IN SUPERCONDUCTORS. Kulik, I. O. (Physical-Technical Inst. of Low Temperatures, Kharkov). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 2, 24-8(1967). (In Russian).

A rigorous proof is given of a formula used frequently for the tunnel current in a superconductor. The derivation is based on the Hamiltonian introduced by M. H. Cohen et al., (Phys. Rev. Lett. v. 8, 316, 1962), and shows that the tunnel current through the contact between two normal or superconducting metals can be expressed in terms of the state densities of these metals near the Fermi surface. The formula derived is shown to hold for arbitrary finite temperatures and in superconductors with arbitrary condensation, and also in the presence of any singularity in the spectrum of the normal or superconducting metal, connected in a narrow vicinity of the Fermi surface. This makes the formula applicable for the tunnel effect in metallic films or in semimetals. The results also have a bearing on the Josephson current. (ATD)

31378 STEADY CURRENT FLOW IN SUPERCONDUCTORS OF THE SECOND KIND. Jakeman, E.; Pike, E. R. (Royal Radar Establishment, Great Malvern, Eng.). Proc. Phys. Soc. (London), 91: 422-4(June 1967).

A "third Ginzburg–Landau equation" is discussed, which describes the electric-field distribution inside a local superconductor carrying a steady current, and solutions are obtained for two simple cases. (auth)

31379 NUCLEAR METHODS OF LOW-TEMPERATURE THERMOMETRY. Kolac, Miroslav (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez); Svec, Karel; Sebek, Josef. Jad. Energ., 13: 129-35(Apr. 1967). (In Czech).

Some aspects of low-temperature thermometry using gamma-ray anisotropy from oriented nuclei are analyzed. Angular distributions of gamma radiation from ^{60}Co aligned in cerium magnesium nitrate (agreement with experiment above 0.018°K) and polarized in iron are calculated in detail. (auth)

31380 THERMAL TRANSPORT ACROSS SUPERCONDUCTING SOLDER JOINTS NEAR 0.1°K. Steyert, William A. Jr. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Rev. Sci. Instrum., 38: 964-6(July 1967). (LA-DC-8400).

Heat transfer rates across various types of soft solder joints are investigated between 0.06 and 0.5°K using a $^3He-^4He$ dilution refrigerator. For Cd–Bi junction and thin (10 μ) Sn–Pb junctions, the heat flux per unit area and unit temperature difference is $4.7 \times 10^6\ T^{2.74}$ erg/sec. This rate is about twice that predicted by the theory of Little. Junctions of Sn–Pb and Sn–In about 40-μ thick have a much lower conductance. The thermal conductivity of bulk Sn–Pb solder is found to be $9900\ T^{2.31}$ erg/sec-cm-°K. (auth)

31381 SUPERCONDUCTING MAGNETIC LENSES WITH POLE PIECES OF RARE EARTH METALS. Bonjour, Pierre; Septier, Albert (Faculte des Sciences, Orsay, France). Compt. Rend., Ser. A and B, 264: 747-50(Mar. 6, 1967). (In French).

By using pole pieces of Dy and Ho and a superconducting excitation coil, it is possible to develop protected magnetic lenses of low bulk where the maximum field easily attains 5 Ts; these lenses can focus high-energy electrons from 1 to 5 MeV with focal distances less than 10 mm. (tr-auth)

Plasma and Thermonuclear Physics

Refer also to abstracts 30570, 30571, 30573, 30580, 30584, 30586, 30587, 30591, 30592, and 30679.

31382 (CONF-661016) PROCEEDINGS OF THE 1966 SYMPOSIUM ON ENGINEERING PROBLEMS OF CONTROLLED THERMONUCLEAR RESEARCH HELD OCTOBER 3–6, 1966, IN GATLINBURG, TENNESSEE. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. 410p. Dep. CFSTI.

Separate abstracts were prepared for 15 of the included papers. For abstracts of the remaining papers see CONF-661016 in the report number index. (M.O.W.)

For abstracts of individual papers see: 30580–30587, 31197, 31347–31349, 31386, 31387, and 31396.

31383 (AEC-tr-6672) NUCLEAR FUSION (TRANSLATED SELECTED ARTICLES). Translated from Nucl. Fusion, 5: 267-78; 299-329(1965). 122p. Dep. CFSTI.

The seven translated articles appeared previously in NSA as 20: 12212, 12213, 12214, 12218, 12219, 12220, and 12221. The titles of the papers are, respectively, kinetic theory of electromagnetic waves in an unbounded plasma, plasma equilibrium in a toroidal chamber with a traveling magnetic field, Cherenkov absorption of Alfven waves and of fast magnetoacoustic waves in an inhomogeneous plasma, normal modes of plasma oscillation, electric conductance of turbulent plasma, effect of an electric field on the spectrum of oscillations in an inhomogeneous plasma, and the effect of a cold plasma component on the stability of an inhomogeneous hot plasma. (M.O.W.)

31384 THIRD CZECHOSLOVAK CONFERENCE ON ELECTRONICS AND VACUUM PHYSICS TRANSACTIONS, HELD IN PRAGUE ON SEPTEMBER 23rd–28th, 1965. Paty, Libor (ed.). Prague, Publishing House of the Czechoslovak Academy of Sciences, 1967. 730p. (CONF-650987).

Separate abstracts were prepared for 23 of the included papers. Two papers appeared previously in NSA as: 19: 33471 and 20: 12196. (M.O.W.)

For abstracts of individual papers see: 30748, 30749, 31225, 31226, 31284, 31392, 31393, 31404–31407, 31433–31442, 31464, and 31470.

Confinement and Heating of Plasma

Refer also to abstracts 30581–30583, 30585, 31197, and 31347–31349.

31385 (CLM-R-70) A STUDY OF THE END LOSSES FROM A THETA PINCH USING PIEZOELECTRIC PRESSURE PROBES. Bodin, H. A. B.; Bunting, C. A. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). Jan. 1967. 14p. Dep. CFSTI. UK 1s. 9d.

A 1-mm-diameter piezoelectric pressure probe with a response time of 0.5 μsec has been developed and used successfully to study the pressure distribution of the plasma escaping from the end of a theta pinch. (auth)

31386 (CONF-661016, pp 35-52) THE QUASI FORCE-FREE MAGNETIC FIELD SYSTEM OF MAGNETIC TRAP STABILITY EXPERIMENT MARK II. Francis, G.; Smart, D. L.;

Medford, R. D. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.).

Design criteria are given for a pulsed minimum-B (Ioffe type, l = 2) magnetic well which is produced by mounting straight bars inside a large vacuum tank. The mirror fields are produced by two pairs of transverse insulated bars and the l = 2 stabilizing field by four longitudinal insulated bars. A novel "reflector bar" system, used for minimizing the force on the four longitudinal bars, is described and analyzed in detail. In particular, inductance calculations and minimum force conditions which allow for image currents in the vacuum shell, and an analysis of the forced oscillations of the bars are described. An analysis of current distribution is also included which yields analytic solutions, in the presence of skin effect, for the decay of current in the "reflector bar" system toward the steady-state dc currents. (auth)

31387 (CONF-661016, pp 72-6) DESIGN AND CONSTRUCTION OF A CUSP MAGNETIC FIELD DEVICE FOR PLASMA CONTAINMENT. Gallagher, Charles C.; Combes, Lewis S.; Levine, Morton A. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.).

A plasma containment device designed to employ crossed cusp and toroidal fields was built. It consisted of a toroidal glass chamber enclosed by six coils. With current flowing in the opposite sense in adjacent coils, there seem to be six cusps around the toroid. The toroidal field coil was wound perpendicular to the cusp field coils. Preliminary measurements, using both optical and magnetic diagnostic methods, indicated that the desired magnetic configurations were attained and that the plasma was contained and heated. (M.O.W.)

31388 (JUL-457-PP) INVESTIGATION ON THE COMPRESSION AND THE CONTAINMENT OF A PLASMA IN CUSP GEOMETRY. Belitz, H. J.; Kugler, E. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Plasmaphysik). Jan. 1967. 14p. (CONF-661041-3). Dep.

From 1st European Conference on Controlled Fusion and Plasma Physics, Munich, Germany.

Discharging a 10-kJ 25-kV capacitor bank on a pair of coils in such a way that the electric currents in the two coils have opposite directions, a cusp-shaped plasma (electron densities of about 10^{17} cm^{-3}, electron temperature up to 200 eV) is produced. The maximum magnetic field was 75 kG at the line and point cusps, the half-period 3.6 μsec. Due to this short half-period the plasma could be contained no longer than 2.5 μsec. With a crowbar system (time constant 20 μsec) the containment of the plasma was strongly improved. Using a streak camera and spectroscopic methods, the space and time dependence of the electron density and an estimate of the electron temperature are obtained. (auth)

31389 (MATT-Trans-39) ADJUSTMENT OF THE "SIRIUS" STELLARATOR. Burchenko, P. Ya.; Vasilenko, B. T.; Volkov, E. D.; Nikolaev, R. M.; Potapenko, V. A.; Sebko, V. P. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translated for Plasma Physics Lab., Princeton Univ., N. J., from a Russian report. 18p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The adjustment of the magnetic system of the stellarator was conducted by magnetic measurements, correction by a single passage of a circular electron beam, and correction by multiple passage of a low-energy electron beam. The elements of the magnetic system were correctly regulated and the presence of magnetic surfaces in the corrected system in the approximation of the guiding center of a separate particle was shown by the combination of these methods. (M.O.W.)

31390 HIGH VELOCITY ELECTRONS OF THE POSITIVE COLUMN OF A CONTINUOUS CURRENT DISCHARGE IN GASES. Parvan, Radu (Univ., Bucharest). Compt. Rend., Ser. A and B, 264: 1231-4(Apr. 24, 1967). (In French).

A study was made to determine if the fast electrons, strongly accelerated in the vicinity of the cathode, continue their path in the positive column both when the tube is straight and when it curved in different forms. The results showed that high velocity electrons exist in the positive column whatever its length and form. These fast electrons play an important role in the production of ionizations and excitations. (J.S.R.)

31391 DIFFERENCE FREQUENCY HARMONIC ION HEATING. James, C. R.; Thompson, W. B. (Univ. of Alberta, Edmonton). Can. J. Phys., 45: 1771-81(May 1967).

The heating of a magnetized hot diffuse plasma using the difference frequency signal generated from two high-frequency (35 GHz) transverse waves is examined. The plasma is described by the cold plasma model and a series expansion of harmonics is used to obtain a solution to the equations. It is shown that the energy absorbed by the ions can be made inversely proportional to the collision frequency and the fourth power of the driven frequency and proportional to the fourth power of the driven electric field intensity. An investigation of the sensitivity of the heating process to fluctuations in frequency, density, and dc magnetic field is carried out. (auth)

31392 BUILDUP OF A BEAM-GENERATED PLASMA IN A MIRROR MACHINE. Piffl, V.; Seidl, M.; Sunka, P.; Ullschmied, J. (Inst. of Plasma Physics, Prague). pp 51-64 of Third Czechoslovak Conference on Electronics and Vacuum Physics, Transactions, Held in Prague on September 23rd-28th, 1965. Paty, Libor (ed.). Prague, Publishing House of the Czechoslovak Academy of Sciences, 1967.

See CONF-650987.

The buildup of a plasma in a mirror machine after the electron beam is switched on is described. The plasma reaches its final stage in a succession of transitory stages which can also be observed when the neutral gas pressure is varied and the beam current is kept constant. The experiment was performed in a conventional mirror machine. (M.O.W.)

31393 MEASUREMENT OF CHARGE CARRIERS EFFUSED FROM GLOW DISCHARGE. Hinzpeter, G. (Institut fuer Gasentladungsphysik, Greifswald, Ger.). pp 97-101 of Third Czechoslovak Conference on Electronics and Vacuum Physics, Transactions, Held in Prague on September 23rd-28th, 1965. Paty, Libor (ed.). Prague, Publishing House of the Czechoslovak Academy of Sciences, 1967. (In German).

See CONF-650987.

An experimental study of the ambipolar effusion method proposed by Pahl is described. Investigations have been carried out in straight discharge tubes with diameters between 3.0 and 5.0 cm constructed with a small hole (D = 10 to 100 μm) in the wall. Positive ions and electrons, which diffused out of the positive column to the wall, streamed out of the leak and were separated in the following vacuum chamber, focused and accelerated to the collector. An electronic coupling circuit kept the potential of the lens system at the level of the wall potential near the leak and followed low-frequency changes. The effused ion current rises in proportion to the discharge current. In a discharge tube with a diameter of 4 cm and 2 torr neon pressure the current density amounts to 10^{-7} A/cm^2 and 10^{-5} A/cm^2 at discharge currents between 0.1 and 100 mA. The current is approximately ambipolar. It is shown that a disturbance occurs if the mean free path becomes smaller than the diameter of the hole. The ion current density remains constant below this limit for variable hole diameter, whereas by exceeding the limit the current density falls. (auth)

31394 DETERMINATION OF THE ADIABATICITY PARAMETER ρ_L/R FOR AN ELECTRON MOVING IN AN AXIALLY-SYMMETRICAL MAGNETIC TRAP. Dubinina, A. N.; Krasitskaya, L. S. (Novosibirsk State Univ., USSR). JETP Lett. (USSR) (Engl. Transl.), 5: 184-6(Apr. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 230-3(Apr. 1, 1967).

The dependence of the lifetime, τ, of electrons captured in a magnetic trap on the magnetic field was investigated experimentally. An attempt was made to find the numerical value of the adiabaticity parameter. The maximum lifetime during the time of the experiments was 410 sec (5×10^7 Larmor revolutions) and was determined by scattering by the residual gas. The experimental setup was a magnetic trap of mirror configuration. Sixty-five plots of the lifetime against the magnetic field were obtained at different electron energies, mirror ratios, and angles. (M.H.R.)

Diagnostics of Plasma

Refer also to abstract 31286.

31395 (BRL-MR-1847) SURVEY SPECTRA OF A PINCHED ARGON PLASMA. Sleator, D. B.; Rudd, R. A. (Ballistic Research Labs., Aberdeen Proving Ground, Md.). June 1967. 30p.

Preliminary experiments were performed to determine the feasibility of measuring temperature in an argon theta pinch tube by the two-line ratio method. Calculations were made showing the temperature errors to be expected and the degree to which various types of thermal equilibrium exist as a function of time and electron density. Time integrated spectrograms were taken and a number of argon II lines were identified for which gf values are known. Densitometer traces of the films indicated that the line shapes are suitable for the two-line method and an approximate calculation was made indicating a temperature of 3.5×10^4 °K. It was concluded that time resolved measurements would be desirable. (auth)

31396 (CONF-661016, pp 355-8) MECHANICAL DESIGN AND METHODS FOR CONSTRUCTING PLASMA PROBES. Matlock, O. D. (Oak Ridge National Lab., Tenn.).

Heat transfer from probes employing a static oil-filled medium

is discussed. A design of bare wire probes and their assembly, which provides quick and flexible conversion, is described. A novel method will be illustrated for framing fine wire grids. (auth)

31397 (INR-782/XVIII/PP) ANALYSIS OF POPULATION OF EXCITED STATES OF IONS AND ITS APPLICATION TO ELECTRON TEMPERATURE AND DENSITY MEASUREMENTS. Suckewer, Szymon (Institute of Nuclear Research, Warsaw (Poland)). 1967. 33p. Dep.

Step-wise excitations of ions are discussed and densities N_e of electrons at which the solar corona model is applicable to plasma are estimated. For this case the population of 2^1D_2 and $3^3P_2^0$ states of C_{III} ion was calculated. Expressions for the ion densities at selected excited states, at which corona relations are not applicable, were obtained taking into account collisional de-excitation transitions. Dependence of density of C_{III} ions in states 2^1D_2 and $3^3P_2^0$ on N_e and kT_e was determined for this particular case. (auth)

31398 (IPP-3/51) TRANSMISSIONSMESSUNGEN ELEKTROAKUSTISCHER WELLEN IM GHz-FREQUENZBEREICH. (Transmission Measurements of Electroacoustic Waves in the GHz-Frequency Range). Tutter, M. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Jan. 1967. 30p. (In German). Dep.

In the positive column of an argon low-pressure gas discharge, waves in the GHz range were transmitted parallel as well as perpendicular to the tube axis between two probes. These waves were identified as electroacoustic ones by means of their dispersion relation. The observed dispersion is described better by the equation $\omega/\omega_p = 1 + 2\ KT \cdot k^2/m\omega_p^2$) (Pavkovich a.o.) than by the Bohm and Gross formula $\omega^2 = \omega_p^2 + 3\ KT \cdot k^2/m$. From the difference of the damping of the waves running with the electron drift and those running against it it is concluded that the damping is caused by collisions. The phase of the waves at the place of their generation by the electromagnetic field is extrapolated. (auth)

31399 (SSD-TR-67-88) PRESSURE GAUGE FOR PLASMAS SUBJECTED TO LARGE DYNAMIC ELECTRIC AND MAGNETIC FIELDS. Grabowsky, W. R.; Durran, D. A.; Gerard, M. E. (Aerospace Corp., El Segundo, Calif. Aerodynamics and Propulsion Research Lab.). May 7, 1967. 9p. (TR-1001(2240-10)-8. CFSTI.

A static pressure gage, comprised of a transducer and a resistance bridge, for use in high-temperature (4000°K), high-pressure (0.5 to 10 atm), plasma flow of short duration (10 msec) is described. The transducer is electrically insulated from the flow and used when the plasma is 1 kV above the instrumentation reference. The gage output is free of negative pickup when used in a 4.0-Wb/m^2 time-varying, crow-barred sinusoidal negative field of 4-msec quarter wavelength. (auth)

31400 COMPOSITION OF A NITROGEN PLASMA IN THE TEMPERATURE RANGE FROM 1000 TO 12,000°K AT PRESSURES FROM 1 TO 50 ATM. Irmer, J.; Worm, M. (Physikalisch-Technisches Institut, Deutsche Akademie der Wissenschaften Berlin). Z. Phys. Chem. (Leipzig), 231: 215-27(1966). (In German).

Calculations were made of the concentration of particles per cm^3 for the above pressure and temperature ranges, taking into account N_2^+. (J.S.R.)

31401 STUDY BY GRID PROBE OF THE IONIC PARAMETERS OF AN ALKALINE PLASMA. Felden, Marceau; Haug, Robert; Schirmann, Daniel (Faculte des Sciences, Nancy). Compt. Rend., Ser. A and B, 264: 1243-6(Apr. 24, 1967). (In French).

A grid probe is placed in a cesium plasma. By polarization of the electrodes, the ionic parameters of the plasma (density, plasma potential, and distribution function of energies) were measured. The good agreement with the values obtained by electronic collection was verified. (tr-auth)

31402 MEASUREMENT OF THE DENSITY OF A PLASMA IN EVOLUTION OBTAINED BY LASER IONIZATION USING A FABRY-PEROT INTERFEROMETER. Bize, Daniel; Consoli, Terenzio; Slama, Lucien; Stevenin, Pierre; Zymanski, Micheline (CEN, Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. A and B, 264: 1235-8(Apr. 24, 1967). (In French).

The measurement of the evolution of the plasma bubble density obtained by laser ionization was described. A Fabry-Perot interferometer operating on the wave length $\lambda = 2$ mm permits this measurement in the phase where an optical method is difficult to apply. (tr-auth)

31403 OBSERVATION OF PLASMA ION OSCILLATIONS IN A LASER-PRODUCED PLASMA. Weichel, Hugo; Avizonis, P. V.; Vonderhaar, D. F. (Air Force Weapons Lab., Kirtland Air Force Base, N. Mex.). Phys. Rev. Lett., 19: 10-12(July 3, 1967).

Experiments with 6943-Å light scattered from a high-density carbon plasma have resulted in the spectroscopic observation of ion wings produced by plasma ion oscillations. For an energy density of 200 J/cm^2 and a pulse half-width of 90 nsec, the maximum separation of the ion wings was found to be 0.9 Å. This corresponds to a plasma electron temperature of more than 25 eV and a density of 10^{19} electrons/cm^3. (auth)

31404 APPLICATION OF THE HIGH-FREQUENCY MASS SPECTROMETER FOR INVESTIGATING GLOW DISCHARGES. Martisovits, V. (Comenius Univ., Bratislava). pp 103-6 of Third Czechoslovak Conference on Electronics and Vacuum Physics, Transactions, Held in Prague on September 23rd-28th, 1965. Paty, Libor (ed.). Prague, Publishing House of the Czechoslovak Academy of Sciences, 1967. (In German).

See CONF-650987.

A theoretical analysis of the possibility of investigating the low-pressure discharge using a Bennett-type rf spectrometer is described. The technique of treating the mass spectrum, considering the distribution function of the initial energy of positive ions, is pointed out. An electronic feedback circuit compensating low-frequency plasma vibrations is suggested for stabilizing the plasma potential. (auth)

31405 MEASUREMENT OF PLASMA PARAMETERS IN STANDING STRIATIONS BY THE MICROWAVE METHOD. Studnicka, J. (Charles Univ., Prague). pp 161-6 of Third Czechoslovak Conference on Electronics and Vacuum Physics, Transactions, Held in Prague on September 23rd-28th, 1965. Paty, Libor (ed.). Prague, Publishing House of the Czechoslovak Academy of Sciences, 1967. (In German).

See CONF-650987.

An adaptation of the hf resonator method is described for measurements of stationary striations in the positive column. This adapted method enables one to measure the axial variation of electron density and collision frequency and their phase shift with respect to the luminous intensity. The necessary equations are derived and the conditions of the applicability of this method are indicated. The method has been verified by measurement on a discharge tube filled with a mixture of Ne and H_2. (auth)

31406 NON-THERMAL NOISE SOURCES IN PLASMA WITHOUT A MAGNETIC FIELD AND THEIR INFLUENCE UPON MICROWAVE DIAGNOSTICS. Prinzler, H. (Heinrich-Hertz-Institut, Berlin). pp 221-2 of Third Czechoslovak Conference on Electronics and Vacuum Physics, Transactions, Held in Prague on September 23rd-28th, 1965. Paty, Libor (ed.). Prague, Publishing House of the Czechoslovak Academy of Sciences, 1967. (In German).

See CONF-650987.

The interaction between microwave fields and arc discharges is discussed in general. (auth)

31407 MICROWAVE EQUIPMENT FOR STUDYING LOSS PROCESSES IN A DISCHARGE. Lukac, P. (Comenius Univ., Bratislava). pp 223-6 of Third Czechoslovak Conference on Electronics and Vacuum Physics, Transactions, Held in Prague on September 23rd-28th, 1965. Paty, Libor (ed.). Prague, Publishing House of the Czechoslovak Academy of Sciences, 1967. (In German).

See CONF-650987.

Microwave equipment for measuring the change of resonance frequency and quality of the cavity as a function of time after interrupting the dc glow discharge is described. To enable the measurement of the time dependence of the change of frequency and quality of the cavity at a fixed time, shorter than 1 ms after the discharge is interrupted, the repeller of the klystron is modulated by triangular impulses. This will ensure higher preciseness of the measurement. The results are given of the loss process measurements. (auth)

31408 EFFECT OF ELECTRON DENSITY DISTRIBUTION IN PLASMA WAVEGUIDES. Ohkubo, M. (Gunma Univ., Japan). Elec. Eng. Jap. (Engl. Transl.), 86: 9-13(May 1966).

A derivation is provided for the dispersion relation for the E_{01} mode at cutoff frequency in a plasma column with a radial density distribution. The results of the analysis were compared with those for a uniform plasma column. The effect of the radial density inhomogeneity was considered. It was found that in an anisotropic plasma where the density distribution is given by $n = n_0[1 + \delta_p (1 - r^2/a^2)]$, the same cutoff frequency indicates lower electron density than the uniform density model for a positive δ_p and a higher electron density for a negative δ_p. In an isotropic plasma with a parabolic density distribution, the cutoff frequency gives a higher density than the uniform density plasma. This tendency is more pronounced as the dielectric constant of the medium surrounding the plasma becomes higher, and also as the ratio of the diameter of the column and the plasma radius becomes greater. (BBB)

31409 MEASUREMENTS OF VISCOSITY AND THERMAL CONDUCTIVITY OF A PARTIALLY IONIZED ARGON PLASMA. Kanzawa, Atsushi; Kimura, Itsuro. Nippon Koku Gakkaishi, 14: 373-80(Nov. 1966). (In Japanese).

Measurements were made of the viscosity and the thermal conductivity of a partially ionized argon plasma at atmospheric pressure, using a plasma jet which was considered to be in thermal equilibrium. The problem of thermal equilibrium is discussed in detail. The knowledge of the decay of the temperature and axial velocity distributions in the plasma jet permitted the viscosity and thermal conductivity to be obtained numerically, using the equations of continuity, motion, and energy. The influence of the ionization on the viscosity and thermal conductivity could be detected in the results, and it was found that their values calculated using the simple kinetic theory could be used for a rough estimation below 14,000°K. (BBB)

31410 INITIAL STAGE OF SELF-INVERSION OF SPECTRAL LINES. Terpugova, N. S.; Latyshev, N. N. (Siberian Physical-Technical Inst., Tomsk, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 2, 59-63(1967). (In Russian).

An investigation was made of the initial stages of the distortion of the contour of a spectral line of an inhomogeneous plasma as the thickness of the plasma increases with special attention to the critical value of the thickness, at which self inversion sets in, and to its dependence on the homogeneity of the plasma. A set of nomograms for determining the parameters of the line experiencing self-inversion and for solving the parametric equations, and a table of an auxiliary function used in the calculations, are presented. (ATD)

31411 ALLOWANCE FOR THE PARTIAL OVERLAP OF THE LINES WHEN DETERMINING THE OPTICAL THICKNESS OF A PLASMA LAYER BY THE LINEAR ABSORPTION METHOD. Rukosueva, A. V. (Siberian Physical Technical Inst., Tomsk, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 2, 88-91(1967). (In Russian).

A formula is derived for the linear absorption as a function of the optical density of the hyperfine structure components, and concrete calculations are made for the sodium 5890 and 5896 Å lines. The curves obtained by means of the calculation are used to determine the density of sodium atoms in a 30-MHz electrodeless discharge in sodium vapor. The results agreed with those obtained by the vapor-tension method. It is shown that neglect of the partial overlap of the components leads to an underestimate of the results, which may reach 50%. (ATD)

31412 MICROCALORIMETER FOR MEASURING THE SPATIAL ENERGY DENSITY DISTRIBUTION IN A PARTICLE FLUX. Blagoveshchenskii, V. M. (Physical-Technical Inst., Sukhumi, USSR). Teplofiz. Vysok. Temp., 4: 884-5(Nov.-Dec. 1966). (In Russian).

Descriptions are given of a microcalorimeter with a constant supporting temperature (maintained by cool running water) with the minimum density recording of 4×10^{-6} VT/cm^2. The microcalorimeter was used for measuring spatial distribution of energy in the flux of argon plasma flowing from a pulsed source with a mean energy ~300 eV. (R.V.J.)

31413 MAXIMAL CONDUCTIVITY OF MULTICOMPONENT MIXTURES OF IONIZED GASES. Alievskii, M. Ya.; Radchenko, R. V. (Ural Polytechnic Inst., Sverdlovsk, USSR). Teplofiz. Vysok. Temp., 4: 760-7(Nov.-Dec. 1966). (In Russian).

A mathematical description of the conditions for the existence of a maximum in the conductivity of a mixture of ionized gases is presented as a function of their thermodynamic parameters. In the absence of a magnetic field (or in a direction along the field) the following expression is valid to a sufficient degree of accuracy: $\sigma^{-1} = \Sigma_j \sigma_j^{-1} = \sigma_{ei}^{-1} + \sigma_{ea}^{-1}$. Here the term σ_{ei}^{-1} is determined by the collisions of the electrons with ions of all the components, and the term σ_{ea}^{-1} by the collisions of the electrons with nonionized atoms. The conductivity of the j-th ionized gas can be expressed by a quantity of the order of the time of the free flight path of an electron in the gas $\sigma_j = (n_e e^2 \tau_{0j}/m_e)$, $\tau_{0j}^{-1} = (\tau_j^+)^{-1} + \tau_j^{-1}$. Thus $\sigma_{ei}^{-1} = (m_e/n_e e^2)\, \Sigma_j (\tau_j^+)^{-1}$, $\sigma_{ea}^{-1} = (m_e/n_e e^2)\, \Sigma_j \tau_j^{-1}$. On this basis, expressions are derived for the maximum conductivity and the optimum composition of a two-component ionized mixture, and for a gas (or mixture of gases) with one ionized additive. (ATD)

31414 CORRELATION FOR INVESTIGATION OSCILLATION IN STATIONARY GAS DISCHARGE. Korenevskii, L. N.; Belousov, V. N.; Sobolev, S. S.; Fetisov, A. F. Teplofiz. Vysok. Temp., 4: 786-93(Nov.-Dec. 1966). (In Russian).

Descriptions are given of the design and performance of a device for developing correlated functions of electrical signals at a frequency range from 10 to 200 kHz. The device was designed for investigations of helium discharge positive cylinder oscillations in strong magnetic fields. (tr-auth)

31415 SPECTRAL LINE SHAPE IN AN OPTICALLY DENSE PLASMA. Preobrazhenskii, N. G. Opt. Spectros. (USSR) (Engl. Transl.), 22: 95-9(Feb. 1967).

Translated from Opt. Spektros., 22: 179-87(Feb. 1967).

The radiative transfer equation is used to obtain a general expression for the profile of a spectral line radiated by an optically dense inhomogeneous layer of plasma. From an analysis of this expression various cases of profile formation can be discussed, beginning with the simplest and concluding with complex profiles with asymmetric self-reversal. Calculations are carried out for the effect on the line intensity distribution of a concentration gradient of absorbing atoms and of a radial variation of the width of the initial line profile. A number of conclusions are reached concerning the physical meaning of the so-called degree of inhomogeneity of the plasma. (auth)

31416 A SEALED-OFF MICHELSON-TYPE CO_2 LASER FOR DIAGNOSTIC STUDIES OF GASEOUS PLASMAS. Witteman, W. J. (Philips Research Labs., Eindhoven, Netherlands). Appl. Phys. Lett., 10: 347-9(June 15, 1967).

An experimental arrangement of a Michelson-type CO_2 laser for plasma diagnostic studies of ac discharges is described. The principle of the apparatus is based on the phenomena of strong competition between the rotational transitions. If a phase shift is caused by the plasma to be studied, the intensity distribution of the lasing transitions is changed. The system has been used successfully for measuring (with a wavelength of 10.6 μ) changes in refractive index on the order of 10^{-5}. (auth)

31417 PLASMA DENSITY CONTOUR MEASUREMENTS USING MOLECULAR ION BEAM BREAKUP. Jobes, F. C.; Hickok, R. L. (Mobil Oil Corp., Princeton, N. J.). Rev. Sci. Instrum., 38: 928-31(July 1967).

Density contours of a magnetically confined plasma were determined by probing the plasma with an energetic molecular ion beam and measuring the atomic ions produced by collisional dissociation. The atomic ions are separated from the primary beam by the magnetic field. A 1.8-MeV H_2^+ beam was used to measure the density contours of a magnetically confined energetic arc with a spatial resolution in the plane of the measurement of 0.04 cm^2 and a measurement time of 80 msec. (auth)

31418 MEASUREMENT OF THE DENSITY OF MERCURY VAPOR UNDER NONSTATIONARY DISCHARGE CONDITIONS. Barskaya, A. Ya.; Sena, L. A. (Scientific-Research Inst. of Direct Current, Leningrad). Zh. Tekh. Fiz., 37: 538-41(Mar. 1967). (In Russian).

An ionic densitometer has been employed to measure the density of mercury vapor in mercury vapor arcs under a variety of conditions. The mercury vapor density was found to be greater when the cathode spot was free than when it was fixed. The density rose more rapidly when a previously fixed cathode spot was suddenly freed than it fell when a previously free spot was suddenly fixed. It was also found that when a mercury droplet was allowed to fall onto a hot metal surface in the arc chamber, the mercury vapor density rose suddenly, reaching its maximum value within $\frac{1}{8}$ sec, and then fell during the course of 5 to 20 sec. It is suggested that the higher mercury vapor pressure in the arc with the free cathode spot is due to evaporation on the hot glass wall of the discharge tube of mercury droplets sprayed out by the free cathode spot. It was found that the mercury vapor density in a constriction in a mercury arc discharge increased when the discharge current through the constriction was decreased while the total cathode was held constant. It is concluded that the ionic densitometer can be employed to measure gas densities in different nonstationary processes. (ATD)

31419 INFLUENCE OF TURBULENCE ON THE ACCURACY OF MICROWAVE "CUTOFF" MEASUREMENTS OF PLASMA CONCENTRATION. Kislyakov, A. I.; Larionov, M. M.; Rozhdestvenskii, V. V. Zh. Tekh. Fiz., 37: 584-7(Mar. 1967). (In Russian).

The electron densities of plasmas in the "Al'fa" installation were compared as determined by the cutoff of 4 and 8 mm wavelength microwaves with the ion densities determined at the same instants from the attenuation of a beam of 10 keV hydrogen atoms in order to assess the influence of plasma turbulence on the accuracy of the microwave cutoff measurements. In the Al'fa installation the plasma, confined in a chamber with conductive walls, is heated by a discharge in the presence of a weak longitudinal magnetic field. Turbulence develops in the plasma, which makes microwave interferometer measurements very difficult or impossible during the discharge, although very good interference patterns are obtained during the decay of the plasma after cessation of the discharge current. The electron densities in the plasma after cessation of the discharge, as measured with a microwave interferometer, were in good agreement with the ion densities, as measured with the hydrogen atom beam. When the discharge cur-

rent was flowing, the microwaves were cut off at ion densities, as measured with the atomic beam, that were 2 to 3 times lower than the critical electron densities for cutoff of the microwaves (cutoff was assumed to have occurred when the intensity of the transmitted microwave signal had dropped by 10 db). It is suggested that whereas the atomic beam method measures the average value of the fluctuating plasma density, the microwave cutoff method measures the maximum value of the electron density and it is concluded that this must be taken into account in attempts to measure the densities of turbulent plasmas by the microwave cutoff technique. (ATD)

31420 POSSIBILITIES FOR THE STUDY OF RESONANCES OF IONOSPHERIC PLASMA USING A MUTUAL-IMPEDANCE PROBE. Storey, Owen (Groupe de Recherches Ionospheriques, Saint-Maur-des-Fosses, France); Meyer, Pascal; Aubry, Michel. Compt. Rend., Ser. A and B, 264: 904-7(Mar. 13, 1967). (In French).

The behavior of a four-electrode probe in a typical ionospheric plasma was studied by calculating its mutual impedance as a function of its orientation and of its excitation frequency. The diverse resonances of the plasma, including those being produced for propagation directions oblique to the magnetic field are shown. (tr-auth)

Kinetics of Plasma

Refer also to abstracts 31327 and 31328.

31421 (AFCRL-67-0299) PLANE WAVE PROPAGATION THROUGH A COMPRESSIBLE INHOMOGENEOUS PLASMA. Scientific Report No. 4. Rahneberg, Eric; Tyras, George (Arizona Univ., Tucson, Engineering Experiment Station). Mar. 1967. Contract AF 19(628)-3834. 27p.

The set of hydrodynamic equations together with Maxwell's equations which describe a nonuniform plasma as formulated by Cohen [1962] has been applied to a two dimensional problem where the magnetic field has only one component which is transverse to the direction of propagation and the profile is of the form e^{-Bx}. These assumptions lead to a set of second order coupled electromagnetic and hydrodynamic differential equations which describe the region under consideration. Solutions to this coupled set have been obtained by the application of the method of Frobenius. Considerable simplification resulted in the solutions when the assumption that the rms velocity of the electrons is much smaller than the speed of light was made. The resulting set of approximate solutions has been applied to the problem of obtaining reflection and transmission coefficients for the case of a plane wave incident from free space upon a layer of compressible inhomogeneous plasma. (auth)

31422 (ARL-67-0055) A REVIEW OF DISPERSION RELATIONS FOR LOW FREQUENCY WAVES IN QUIESCENT MAGNETO PLASMAS. Anton, H.; Friz, W. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Mar. 1967. 17p. CFSTI.

A summary is given of possible waves in a quiescent cesium magnetoplasma. Dispersion relations for the different low-frequency waves are given graphically, and the influence of external magnetic field strength and particle density is shown. (auth)

31423 (M-65-4FR) WAVE PROPAGATION IN A NON-MAXWELLIAN MAGNETOACTIVE NONLINEAR PLASMA. Final Report, June 10, 1965-October 31, 1966. Thomas, A. S. (Thomas (A. S.) Inc., Westwood, Mass.). May 1967. Contract AF19(628)-5195. 89p. (AFCRL-67-0319).

The interaction of an electromagnetic wave normally incident on a non-Maxwellian, nonlinear, magnetoactive, homogeneous plasma slab is studied. The wave is taken to be either right-hand circularly polarized or left-hand circularly polarized. First integral expressions for the conductivity are evaluated numerically as power series in field intensity. Then, using these expressions, the reflection and transmission coefficients are computed by employing the Runge-Kutta technique to integrate Maxwell's equations numerically step-by-step through the plasma slab. For most of the cases considered, the reflection and transmission coefficients decrease as the incident field increases. (auth)

31424 (NP-16805) PENNING DISCHARGE IN A STRONGLY INHOMOGENEOUS MAGNETIC MIRROR FIELD. Hopfgarten, N.; Johansson, R. B.; Nilsson, B.; Persson, H. (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). May 25, 1967. 10p. Dep.

An attempt was made to produce an electric field parallel to the magnetic lines of force in a Penning discharge in a strongly inhomogeneous magnetic mirror field. This was found to be theoretically possible for a collisionless plasma in an inhomogeneous magnetic field provided there is anisotropy in the velocity distributions of ions and electrons. (M.O.W.)

31425 (UCRL-17448) FORMATIVE TIME OF CROSSED-FIELD BREAKDOWN. Kunkel, Wulf B.; Sherwood, Arthur R. (California Univ., Berkeley. Lawrence Radiation Lab.). Mar. 1967. Contract W-7405-eng-48. 5p. (CONF-670810-1). Dep. CFSTI.

From 8th International Conference on Phenomena in Ionized Gases, Vienna, Austria.

A study of the formative time of a gas breakdown in an electric field at right angles to a very strong uniform static magnetic field is described. The breakdown was accomplished essentially by primary electron avalanches, and the effect of secondary electrons released at the cathode was, in a first approximation, neglected. The resulting simplifications permitted theoretical predictions, based on extrapolated values of observed or computed ionization rates and drift speeds, for the breakdown time as a function of the fields and the gas density. The fair agreement between observed and predicted formative times was taken as a partial confirmation of the theory. (M.O.W.)

31426 (UCRL-50227) A RELATIVISTIC CALCULATION OF THE BREMSSTRAHLUNG SPECTRUM OF A MAXWELL-BOLTZMANN PLASMA. Quigg, Chris (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 6, 1967. Contract W-7405-eng-48. 24p. Dep. CFSTI.

A numerical description of the spectrum of electron-ion bremsstrahlung from a Maxwell-Boltzmann plasma is obtained, using relativistic expressions. Results are given for specific temperatures in the range from 7.5 to 300 keV. (auth)

31427 (NASA-TT-F-479) ELECTRON GAS IN A MAGNETIC FIELD. Lifshits, E. M. Translated from Zh. Eksp. Teor. Fiz., 7: 390-400(1937). 15p. CFSTI.

The kinetic equation is derived for a gas consisting of charged particles in a magnetic field. This equation is used to determine the relaxation time for establishing Maxwell distribution in this gas as well as its thermal conductivity. A bundle of charged particles, plane and cylindrical, is investigated. The dependence of the bundle width on time is determined by means of this equation. (auth)

31428 COOPERATIVE LIGHT SCATTERING FROM THETA-PINCH PLASMAS. Daehler, M.; Ribe, F. L. (Los Alamos Scientific Lab., N. Mex.). Phys. Lett., 24A: 745-6(June 19, 1967).

The scattering of ruby-laser light at 6.25° by a 150-kJ θ-pinch plasma was measured with a two-etalon Fabry-Perot spectrometer. The spectrum shows an intense, narrow central peak, with broad wings whose width and magnitude correspond to the theoretically expected thermal ion feature. (auth)

31429 STUDY OF THE RELATIVISTIC EFFECTS IN PLASMA HIGH FREQUENCY ACCELERATORS. Brambilla, Marco; Canobbio, Ernesto; Collet, Roland (CEN, Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. A and B, 264: 1239-42(Apr. 24, 1967). (In French).

The value of the power beginning with which the relativistic effects are dominant in high-frequency accelerators is given. (tr-auth)

31430 IONIZATION BY HIGH FREQUENCY INDUCTION OF SUPERSONIC FLOWS AND VARIATION OF THE DYNAMIC PROPERTIES OF THESE FLOWS. Dumousseau, Pierre (Ecole de Physique et Chimie Industrielles, Paris). Compt. Rend., Ser. A and B, 264: 776-8(Apr. 24, 1967). (In French).

The various possibilities offered by high-frequency induction for the production of ionization in a supersonic flow are discussed. The dynamic evolution of an ionized flow below a shock tube is considered. It is shown that the evolution of the Mach number and of the corresponding generating temperature depends essentially on the fluid considered and on the reactions produced within it by induction: excitation, dissociation, ionization, and chemical reactions. (tr-auth)

31431 OBSERVATION OF AN EMISSION PEAK AT PLASMA CUTOFF. Tetenbaum, S. J.; Bailey, H. N. (Lockheed Palo Alto Research Lab., Calif.). Phys. Rev. Lett., 19: 12-14(July 3, 1967).

Observations were made of two peaks in the emission from a low-pressure helium discharge. It was established with good accuracy that the second peak corresponds to the plasma cutoff frequency. Emission measurements were also performed in neon, and the results are similar to those in helium. Preliminary data indicate the existence of a peak at plasma cutoff in the emission from an active discharge, where the electron distribution is non-Maxwellian. (J.H.M.)

31432 VISIBLE CONTINUA IN XENON, KRYPTON, AND NEON. Prince, J. F.; Robertson, W. W. (Univ. of Texas, Austin). J. Chem. Phys., 46: 3309-13(May 1, 1967).

An investigation of the continua (2900 to 7000 Å) radiated from positive columns in xenon, krypton, and neon is described for dis-

charges in the pressure range of 5 to 40 torr (neon, 20 to 120 torr) and current range of 0.7 to 5 mA, conditions chosen for normal glow, unconstricted discharges. Experimental results show definitely that these continua are not attributable to free–bound, free–free transitions and indicate that they are of molecular origin, the radiating states being populated by electron excitation of metastable molecules formed by three-body conversion of metastable atoms. (auth)

31433 INFLUENCE OF TRAPPED MAGNETIC FIELD ON PLASMA PARAMETERS IN A THETA PINCH. Labat, J. M. (Faculty of Natural Science, Belgrade). pp 69-74 of Third Czechoslovak Conference on Electronics and Vacuum Physics, Transactions, Held in Prague on September 23rd–28th, 1965. Paty, Libor (ed.). Prague, Publishing House of the Czechoslovak Academy of Sciences, 1967.

See CONF-650987.

The influence of a magnetic field on a hydrogen plasma created by the electrodeless discharge in a theta pinch was studied. A 3.6-kJ condenser battery, discharged into a single turn compression coil, was used to determine the effect of the sign and magnitude of the trapped magnetic field on the plasma compression process, the stability of the plasma cylinder, and the peak values of the density and temperature. (M.O.W.)

31434 TEMPERATURE INFLUENCE ON CYCLOTRON RESONANCE IN A GASEOUS DISCHARGE. Durcek, J. (Transport Coll., Zilina, Czechoslovakia). pp 85-96 of Third Czechoslovak Conference on Electronics and Vacuum Physics, Transactions, Held in Prague on September 23rd–28th, 1965. Paty, Libor (ed.). Prague, Publishing House of the Czechoslovak Academy of Sciences, 1967.

See CONF-650987.

A spectroscopic model was used to determine the absorption of electromagnetic waves in discharge plasma under various conditions. Only the elastic collisions of electrons with neutral molecules were considered and electron–ion or electron–electron interactions were neglected. (M.O.W.)

31435 GENERAL SOLUTION OF LINEARIZED EQUATIONS FOR WAVE PHENOMENA IN PLASMA. Zarybnicky, V.; Pekarek, L. (Inst. of Physics, Prague). pp 117-30 of Third Czechoslovak Conference on Electronics and Vacuum Physics, Transactions, Held in Prague on September 23rd–28th, 1965. Paty, Libor (ed.). Prague, Publishing House of the Czechoslovak Academy of Sciences, 1967.

See CONF-650987.

The study was made to develop a completely general exact solution for the linearized equations for plasma waves, which would make it possible to find, for an arbitrarily chosen initial condition, the time and space variations of the respective quantities in a manner well suited for processing on an automatic computer. (M.O.W.)

31436 CHANGES IN PLASMA PARAMETERS CAUSED BY AN APERIODICAL DISTURBANCE IN POSITIVE ION DENSITY. Rohlena, Karel (Inst. of Physics, Prague). pp 131-8 of Third Czechoslovak Conference on Electronics and Vacuum Physics, Transactions, Held in Prague on September 23rd–28th, 1965. Paty, Libor (ed.). Prague, Publishing House of the Czechoslovak Academy of Sciences, 1967.

See CONF-650987.

The solutions of the exact electron temperature balance equation, together with the continuity equation and Poisson equation, were investigated. The value of the electron temperature relaxation length was estimated and it was found that its magnitude ranges from a few millimeters to a few centimeters. (M.O.W.)

31437 GENERATION OF STRIATIONS IN LOW-PRESSURE PLASMA IN A STRONG HIGH-FREQUENCY FIELD. Sicha, M.; Vesely, V.; Novak, J. P.; Fuchs, V. (Charles Univ., Prague). pp 139-52 of Third Czechoslovak Conference on Electronics and Vacuum Physics, Transactions, Held in Prague on September 23rd–28th, 1965. Paty, Libor (ed.). Prague, Publishing House of the Czechoslovak Academy of Sciences, 1967. (In German).

See CONF-650987.

An analysis is presented of the process occurring in plasma influenced by a strong high-frequency field. The aim of the analysis is to explain the nature of processes which lead to the generation of ionization waves (striations) by means of a high-frequency field. It is shown that the basic process leading to stratification of the plasma is an increase of the mean electron energy in the region influenced by the high-frequency field. A qualitative analysis was experimentally verified with good agreement. (auth)

31438 PHASE RELATIONS BETWEEN ELECTRON TEMPERATURE, LUMINOUS INTENSITY, AND ELECTRON DENSITY IN A STRATIFIED POSITIVE COLUMN OF A GLOW DISCHARGE. Prostejovsky, Jiri (Charles Univ., Prague. Research Inst. for Vacuum Electronics, Prague). pp 153-9 of Third Czechoslovak Conference on Electronics and Vacuum Physics, Transactions, Held in Prague on September 23rd–28th, 1965. Paty, Libor (ed.). Prague, Publishing House of the Czechoslovak Academy of Sciences, 1967.

See CONF-650987.

An experimental study of the phase shift between the electron concentration and electron temperature was made to help explain the phenomenon of moving striations in the positive column in a dc discharge. The light intensity was also measured. (M.O.W.)

31439 INTERACTION OF ACOUSTIC WAVES WITH PARTIALLY IONIZED GAS. Subertova, S. (Czech Technical Univ., Prague). pp 167-73 of Third Czechoslovak Conference on Electronics and Vacuum Physics, Transactions, Held in Prague on September 23rd–28th, 1965. Paty, Libor (ed.). Prague, Publishing House of the Czechoslovak Academy of Sciences, 1967.

See CONF-650987.

The experimental results of measuring acoustic velocities in a low-pressure discharge and some experimental relations between potentially disturbing sound waves and the dc current of the discharge, acoustic energy, and direction of propagation of acoustic waves with respect to the polarization of electrodes are presented. (M.O.W.)

31440 EXPERIMENTS WITH SHOCK WAVES IN ARGON WITH CESIUM ADMIXTURE. Rothhardt, Ludwig (Institut fuer Magnetohydrodynamik, Jena, Ger.). pp 197-202 of Third Czechoslovak Conference on Electronics and Vacuum Physics, Transactions, Held in Prague on September 23rd–28th, 1965. Paty, Libor (ed.). Prague, Publishing House of the Czechoslovak Academy of Sciences, 1967. (In German).

See CONF-650987.

The dynamics of the plasma in the expansion tube of an inductive–hydrodynamic shock tube, filled with 0.3 torr argon and 0 to 10^{-3} torr cesium, is investigated by means of a drum camera. Furthermore, the current passage through the fast-moving argon–cesium plasmas is studied; current–voltage characteristics are obtained and discussed with regard to basic phenomena. (auth)

31441 RESONANCE ACCELERATION OF PLASMA CLUSTERS. Kracik, Jiri (Czech Technical Univ., Prague). pp 203-9 of Third Czechoslovak Conference on Electronics and Vacuum Physics, Transactions, Held in Prague on September 23rd–28th, 1965. Paty, Libor (ed.). Prague, Publishing House of the Czechoslovak Academy of Sciences, 1967.

See CONF-650987.

An elementary discussion of the simplest relations valid for the magnetohydrodynamic acceleration of plasma clusters and shock waves was presented. It was shown that the resonant state is most advantageous for the system of parallel conductors or coaxial conductors. Also, continuous unlimited acceleration with decreasing magnetic field or increasing electric field is advantageous. For the latter case, there is an autostable circular path. (M.O.W.)

31442 PLASMA IN NON-HOMOGENEOUS RF FIELD. Grigorov, G.; Popov, G. (Sofia Univ.). pp 227-31 of Third Czechoslovak Conference on Electronics and Vacuum Physics, Transactions, Held in Prague on September 23rd–28th, 1965. Paty, Libor (ed.). Prague, Publishing House of the Czechoslovak Academy of Sciences, 1967.

See CONF-650987.

A theoretical survey of the interaction of plasma and a nonhomogeneous radiofrequency field was made in order to verify the results obtained on the plasma of the positive column. A plasma in a diffusion regime situated in a nonhomogeneous rf field with rotation symmetry, created by two thin coaxial rings of the same diameter, is described. (M.O.W.)

31443 LOW-FREQUENCY RESONANCE OSCILLATIONS IN CYLINDRICAL PLASMA COLUMNS. Tanaka, Y.; Yamamoto, K. (Nagoya Univ., Japan). Elec. Eng. Jap. (Engl. Transl.), 86: 1-11 (June 1966).

The mechanism of oscillations of a plasma column was studied in the highly ionized discharge in a Philips Ionization Gage (PIG) discharge tube. In studying the oscillatory behavior of the plasma, it was necessary to consider the ionization mechanism of the PIG discharge. A model of the plasma best suited for predicting the observed oscillatory behavior was proposed. Attempts were made to clarify the relation between the oscillatory behavior and the discharge under operating conditions suitable for the model of the plasma proposed. In addition to the hitherto known modes of the PIG discharge, another mode exists, which is characterized by the magnetron critical field, and may be used to explain excitation mechanisms of various waves in the highly ionized plasma column. The waves excited in the plasma were identified as the ion sound and hydromagnetic wave. Accordingly, this mode was

called the MHD-wave mode. The cooperative behavior of the plasma was considered to be essential in explaining the electron current flow in the magnetron above the critical field. In the PIG discharge, the electron current flows to the anode when electrons lose their energy by ionization, and, thus, supply the current necessary for maintaining the discharge. In this case, the electron diffusion current is much smaller than the discharge current. If a fully ionized plasma with little residual gas can be generated, the PIG discharge in the MHD-wave mode will be capable of generating a strong oscillation efficiently. Such a discharge will be useful for observing the mutual interaction between the magnetron mode and the plasma. (BBB)

31444 MAGNETIC INTERRUPTION OF LARGE CURRENTS IN A LINEAR DISCHARGE PLASMA. Enjoji, H. (Inst. of Physical and Chemical Research, Tokyo). Elec. Eng. Jap. (Engl. Transl.), 86: 36-46(1966).

The properties of a high-current discharge in low-pressure gas were investigated. The type plasma used was a linear discharge generated by a low-voltage, high-capacitance (500 V, 1.1×10^4 to 1.3×10^5 μF) condenser bank. When the magnetic field used for the stabilization for the linear discharge was ac, the alternating field created an eddy current in the electrode. The magnetic field due to this eddy current combined with the externally applied magnetic field to form a new configuration of the magnetic field. The field configuration changed from mirror geometry to cusp geometry and further to hyperboloid geometry. For each configuration of the magnetic field lines, the discharge exhibited different characteristics. In a special mirror field in which the mirror ratio is extremely high, magnetic field lines originating from electrodes pass through the tube wall to the outside of the discharge tube. Charged particles which follow magnetic field lines, in this case, collide with the wall and become neutralized causing a cutoff in the discharge current. In the cusp configuration, charged particles near the edge of electrodes can transfer over into magnetic field lines of hyperboloid geometry. When this happens, the effective area of the electrode is reduced and discharge current is suppressed as the current path in the middle of the gap narrows. When the field configuration changes into the hyperboloid shape, magnetic field lines connecting two electrodes appear. A second discharge can be formed at this point if a sufficient number of electrons still remain in the chamber from the main discharge and if the residual voltage on the condenser bank is sufficiently high. A small delayed pulse of discharge current appears under this condition. To observe the phenomena described above, charged particles comprising the plasma must behave as individual particles without suffering collisions. In addition, various drift mechanisms must be negligible. When these conditions are satisfied, magnetic field lines which form a low-leakage current path can be used to control the current. (BBB)

31445 INVESTIGATION OF A DISCHARGE PLASMA IN HELIUM AND ARGON WITH ADMIXTURE OF CESIUM AND POTASSIUM VAPORS. Morgulis, N. D.; Polushkin, I. N. (Kiev State Univ.). Teplofiz. Vysok. Temp., 4: 745-52(Nov.-Dec. 1966). (In Russian).

An experimental investigation was made of the physical properties of He–Cs, He–K, Ar–Cs, and Ar–K pulse discharges under admixture conditions, when their ionization is limited only by the atoms of the admixture. The pressure of the base inert gas was constant and equal to 600 mm Hg, while the pressure of the admixtures was varied in the interval from 0.01 to 0.5 mm Hg; the density of the discharge current was in the region of J = 4 to 70 A/cm^2. Such a plasma can be considered as a physical model of a mixed gas–plasma semiconductor with shock ionization and "hot" electrons. A description is presented of the necessary conditions for obtaining a quasi-steady-state of the plasma and of the way in which it fills the discharge tube. Determinations were made of the electric field strength, the conductivity, the electron temperature, and the nature of the spectra of the plasma obtained, under different experimental conditions. Several of the physical processes which take place in such a plasma are also described. (ATD)

31446 ON OSCILLATIONS OF CONFINED (CYLINDRICAL) PLASMA WITH HOT ELECTRON CURRENT. Makhan'kov, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 10: 455-60(1967). (In Russian).

Oscillations of a confined cylindrical plasma with hot electron current have been considered. The dispersion equation has been obtained for the case when Debye radius is far more than the transverse size of the system. The excitation conditions and increments for different types of oscillations are obtained under the assumption of mirror reflection. The ions are assumed to be cold. (auth)

31447 SPECTRUM OF POTENTIAL OSCILLATIONS IN NONHOMOGENEOUS PLASMA. Yakovenko, V. M. (Inst. of Radio Physics and Electronics, Moscow). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 10: 461-5(1967). (In Russian).

The spectrum and damping of electromagnetic oscillations originating at a sharp interface of two media with different electrical properties were studied. It is shown that in the presence of charged particles drifting through the interface, the amplification of oscillations is possible. (auth)

31448 PECULIARITY OF ATTENUATION OF LONGITUDINAL WAVE IN A WEAKLY-INHOMOGENEOUS PLASMA. Eidman, V. Ya. (Scientific-Research Radiophysics Inst., Gorky, USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 10: 629-36(1967). (In Russian).

The attenuation factor of a longitudinal wave in a weakly inhomogeneous plasma behaves in a more complex manner than it follows from the geometrical optics approximation. The expression for the oscillation decrement has been derived. (auth)

31449 THEORY OF NONCOHERENT ELECTROMAGNETIC WAVE SCATTERING ON CYLINDRICAL-SYMMETRIC PLASMA STRUCTURES. Yakimenko, I. P. (Kharkov State Univ.). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 10: 637-48(1967). (In Russian).

The method is formulated and considered to solve the problem of plane electromagnetic wave scattering on density fluctuations of a charge in plasma confined by a cylindrical surface. The results are compared with the solution derived on the basis of Born's approximation that permits to find out the characteristic features and the necessity of formulating the boundary problem of electrodynamics. (auth)

31450 OBLIQUE INCIDENCE OF AN ELECTROMAGNETIC WAVE ON COMPRESSIBLE PLASMA CYLINDER. Ryzhova, L. K.; Yakimenko, I. P. (Kharkov State Univ.). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 10: 666-73(1967). (In Russian).

Plane wave diffraction on an infinitely long plasma cylinder is considered with allowance for a spatial dispersion (in a hydrodynamic approximation). The scattering cross sections are obtained for the case of an arbitrary oblique incidence of E and H polarized plane waves. There is investigated the particular cases and connecting procedures to the early papers on the wave scattering on a hot plasma cylinder at a normal incidence and the diffraction on a cold one for an arbitrary incidence. (auth)

31451 REFLECTION OF A PLASMA WAVE AT AN ELECTRON SHEATH. Baldwin, David E. (Yale Univ., New Haven). Phys. Rev. Lett., 18: 1119-22(June 19, 1967).

An electrostatic wave propagating into a region of decreasing electron density is investigated with respect to its absorption and reflection, as a consequence of the onset of strong Landau damping. The theoretical analysis was made for a one-dimensional plasma with uniform electron density for $-\infty < X < 0$ but going to 0 for $X \to +\infty$. (M.O.W.)

31452 SOME ASPECTS OF THE DISCHARGE IN CONTINUOUS CURRENT DUE TO CATHODE ELECTRONS. Ionescu, Theodore V. (Univ., Bucharest). Compt. Rend., Ser. A and B, 264: 1189-91(Apr. 17, 1967). (In French).

By applying a magnetic field parallel to the axis of the tube in the Faraday region, currents 50 times stronger can be obtained in air or in Ar for the same pressure in the tube and the same voltage applied between the anode and the cathode. (tr-auth)

31453 DETERMINATION OF CURRENT DENSITY IN A PLASMA ACCELERATED BY PROGRESSIVE WAVES. Rager, Jean-Pierre; Sitt, Bernard (ONERA, Chatillon-sous-Bagneux, France). Compt. Rend., Ser. A and B, 264: 705-8(Apr. 10, 1967). (In French).

Experimentation with two progressive-wave plasma accelerators, one of which has transverse dimensions almost doubled that of the other, makes it possible to verify that the current density induced in the plasma depends linearly on the $^3/_2$ power of the channel type; this experiment confirms in a wide operation region the evolution of this current density following the $^3/_2$ power of the electric field. (tr-auth)

31454 LENGTH AND DISPLACEMENTS OF Ar I AND Ar II LINES IN A PLASMA JET. Chapelle, Joseph (CNRS, Bellevue, France); Sy, Alassane; Cabannes, Francois; Blandin, Jean. Compt. Rend., Ser. A and B, 264: 853-6(Mar. 13, 1967). (In French).

The length and displacements of some Ar I and Ar II lines emitted by an Ar plasma jet was compared with the lengths and displacements calculated by the Griem theory. The theoretical and experimental results are in good agreement for most of the Ar I lines but there are significant deviations for the Ar II lines. (tr-auth)

31455 HIGH-PRESSURE PULSED ARCS IN HELIUM AND HYDROGEN. Knyazev, Yu. R.; Borovik, E. S.; Mitin, R. V.; Pet-

renko, V. I. Zh. Tekh. Fiz., 37: 523-32(Mar. 1967). (In Russian).

The pulsed arcs investigated were produced by discharging a capacitor bank through a 2 to 6-cm-long arc burning steadily in the gas at a pressure of 0.5 to 6.0 mN/cm^2, except in the case of the longest hydrogen arcs at the highest pressure, when the capacitor bank was discharged through a thin wire because a steady arc could not be obtained. The arc current and voltage were recorded with an oscillograph, the arcs were photographed with a pinhole camera, the arc spectra from 2000 to 6000 Å were photographed, and the peak brightnesses of the arcs were recorded. Peak arc currents up to about 45 kA were achieved. The dynamic current–voltage characteristics obtained from the oscillograms indicated that the arc was in a quasistationary state after the peak current had been reached. At arc currents below 20 kA the spectra contained many bright lines of impurities. At arc currents above 30 kA there was a broad emission spectrum with a few Fraunhofer lines of copper, silver, and tungsten. The peak power per unit length of the arc ranged between about 3 and 6 MW/cm. The peak brightness of the arc was proportional to the peak power per unit length; values as high as 4×10^{10} nit, corresponding to a blackbody surface temperature of about 1.2×10^{4}°K, were recorded. The conditions on the axis of the discharge were calculated from the electric conductivity of the arc and the conditions of energy balance under the assumption that all the energy was carried off by radiation. The plasma was found to be practically completely ionized (ion density, approximately 10^{18} cm^{-3}) with a central temperature of 2.5 to 5.0×10^{4}°K. (ATD)

31456 EXTRAORDINARY AND PLASMA WAVES NEAR THE LOWER HYBRID FREQUENCY. Dnestrovskii, Yu. N.; Kostomarov, D. P.; Chechina, A. A. (Moscow State Univ.). Zh. Tekh. Fiz., 37: 440-6(Mar. 1967). (In Russian).

The roots of the dispersion equation for waves propagating transverse to the external magnetic field in a magnetized plasma and having frequencies close to the lower hybrid frequency are discussed. Although the thermal motions of the ions are neglected, those of the electrons are taken into account; this is necessary because at frequencies close to the hybrid frequencies the phase velocity of the waves is low and becomes comparable with the electron thermal velocities. The roots of the exact dispersion equation for the extraordinary and plasma waves are compared with the corresponding roots of an approximate dispersion equation for plasma waves, derived on the assumption that the plasma waves are strictly longitudinal. A qualitative discussion of the dispersion equations revealed that there is a positive root for the square of the refractive index at frequencies below the lower hybrid frequency, which corresponds to the magnetic sound branch of the extraordinary wave and which transforms at frequencies above the hybrid frequency into a positive root corresponding to plasma oscillations. The approximate dispersion equation also has a positive root at frequencies above the hybrid frequency; this root differs greatly from that of the exact dispersion equation at frequencies close to the lower hybrid frequency, but it rapidly approaches the root of the exact equation as the frequency increases. There also exist negative and complex roots of the complex roots of the dispersion equation; these are discussed briefly. The features of the dispersion equation deduced in the qualitative discussion are illustrated by curves calculated for specific cases. There are given simple analytic expressions for the roots of the dispersion equation that are valid under certain limiting conditions. (ATD)

31457 NONLINEAR THEORY OF LONGITUDINAL WAVES IN A PLASMA. Repalov, N. S.; Khizhnyak, N. A. Zh. Tekh. Fiz., 37: 471-80(Mar. 1967). (In Russian).

The kinetic equation was used to discuss the behavior of one-dimensional longitudinal waves of finite amplitude in a plasma. The effects of collisions and of magnetic interactions are neglected. To simplify the calculation it is assumed that the distribution function is a step function of the velocity, i.e., it is assumed that the plasma consists of a large but finite number of "elementary beams," but the resulting sums are replaced by integrals in the final results. The solution of the kinetic equation is approached through a discussion of its characteristic equations, the equations of motion. Only those solutions are considered that are periodic in an Euler variable. During the calculations the dispersion equations for a plasma consisting of a finite number of beams, and for the linear oscillations of a hot plasma are derived. The results of the general calculations are employed to discuss the long-wavelength oscillations of an electron; plasma and the nonlinear waves in a system of two cold electron beams. It is found that the phase velocity of the long-wavelength oscillations of an electron plasma decreases with decreasing plasma temperature and with increasing amplitude of the oscillations. When the two-beam system is unstable to small perturbations, the amplitude of the oscillations increases to a stationary value that is independent of the initial conditions; an expression is derived for the limiting amplitude of the oscillations in terms of the Langmuir frequencies of the two electron beams. (ATD)

31458 SOLITARY LONGITUDINAL PULSE WAVE IN A PLASMA. Krasovitskii, V. B. Zh. Tekh. Fiz., 37: 493-7(Mar. 1967). (In Russian).

It is shown that under certain conditions a solitary longitudinal wave can exist in a plasma without the discontinuity of the charge density at the boundaries of the pulse exhibited by the solution found by Bohm and Gross. The calculations are based on the hydrodynamic equations of motion and continuity for the plasma electrons, Poisson's equation, and the kinetic equation for the motion of the particles trapped in the potential well of the wave. By methods similar to those employed by Bohm and Gross there is derived a relation betwen the amplitude and phase velocity of the wave and the density of the trapped particles. The density of the trapped particles cannot exceed twice the density of the plasma, and the solitary wave can exist only if the trapped particles are positively charged. The stability of the wave to short-wavelength perturbations is discussed. There is derived a dispersion equation, valid when the density of the trapped particles is low compared with the plasma density, that is formally equivalent to the dispersion equation for the interaction of an infinite compensated electron beam with an ionic plasma. The propagation of a solitary wave in an electron–positron plasma is discussed briefly. In this case there can exist a solitary pulse wave with trapped electrons. (ATD)

31459 INVESTIGATION OF THE DIELECTRIC CONSTANT OF A PLASMA MOVING THROUGH A TRANSVERSE MAGNETIC FIELD. Demidenko, I. I.; Lomino, N. S.; Padalka, V. G.; Sinel'nikov, K. D. Zh. Tekh. Fiz., 37: 498-503(Mar. 1967). (In Russian).

The dielectric constants were measured of plasma bursts from a conical plasma gun moving through transverse magnetic fields with strengths up to 0.2 tesla. The plasmas passed between two 2×4 cm plane parallel electrodes mounted 1.3-cm apart in the magnetic field and connected externally through a resistive load. The dielectric constant was determined by comparing the potential differences developed between the electrodes during passage of the plasmas for different values of the load resistance with theoretical curves, the equation of which is derived. The velocity of the plasma through the magnetic field was determined from the potential difference between the electrodes when they were open circuited. The square of the velocity was a linear function of the magnetic field strength; this indicates that the motion of the plasma in the magnetic field was adiabatic. The velocity of the plasma during its passage between the electrodes was also measured with a shielded electric probe. When the electrodes were open circuited the plasma passed between them without change of velocity; otherwise the plasma was quickly decelerated to a velocity that depended on the load resistance, and when the electrodes were short circuited, the plasma was brought to rest. The dielectric constant of the plasma decreased with increasing magnetic field strength, and the plasma density (calculated from the dielectric constant and the magnetic field strength) increased. For adiabatic motion of the plasma in the magnetic field the product of the dielectric constant, the initial velocity of the plasma, and the magnetic field strength should be independent of the magnetic field strength. This was found to be the case for the dense plasmas used in these experiments, which had densities of about 10^{13} cm^{-3}; but for a 10^{12} cm^{-3} plasma the product of dielectric constant, velocity, and field strength decreased with increasing field strength. This behavior is ascribed to appreciable capture of the less dense plasmas by the transverse magnetic field. (ATD)

31460 EXPERIMENTAL EVIDENCE OF THE ACCELERATION ZONE OF IONS AFTER COMBINING OF TWO HIGH FREQUENCY ACCELERATORS WITH MAGNETIC FIELD GRADIENT. Abgrall, Francois, Bardet, Rene; Consoli, Terenzio; Geller, Richard; Gormezano, Claude (CEN de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. A and B, 264: 762-5(Mar. 6, 1967). (In French).

A plasma formed by an accelerator of the Circe type was injected into the uhf cavity of the Pleiade accelerator. This type of injection and an apparatus for the detection of neutral particles made it possible to clarify the problems due to the electrostatic potentials developed on the walls by the energetic electrons and to verify some theoretical results. (tr-auth)

Production of Plasma

31461 (BMwF-FBK-67-34) DIE ENTWICKLUNG EINES KURZSCHLIESSER-FUNKENSTRECKEN-SYSTEMS. (The Performance of a Passive Crowbar-System). Breuer, W.; Christou, I.; Koch, W. (Technische Hochschule, Brunswick

(West Germany). Hochspannungsinstitut). Apr. 1967. 21p. (In German). Dep.

A spark-gap-device for passive crowbar operation is constructed which can be connected exactly at zero voltage of a ringing discharge. The operating principles of such multi-electrode arrangements at atmospheric pressure are discussed. Experimental work has been undertaken to complete the development of a special trigger generator for 48 crowbar gaps in parallel operation. It was necessary to investigate the problems posed by the parallel working of many such devices. The most serious problem is the prefiring of one crowbar gap at the start of the main discharge since the current in the failing group will raise to a high value. It is possible to overcome these problems by variation of the technical data. The development of the crowbar system for the 1.2 MJ battery project at Jülich has been completed. (auth)

31462 (ML-1495) ONE- AND TWO-DIMENSIONAL STEADY STATE LOW PRESSURE DISCHARGE THEORY. Summary Report II. Shaw, E. K. (Stanford Univ., Calif. Microwave Lab.). Nov. 1966. Contract NAS 3-4100. 170p. (NASA-CR-54665).

It is shown that a pressure theory approach, although approximate, when modified to take into account ion generation can be used to accurately describe a wide variety of dc discharges in the low- and medium-pressure regimes. This modified pressure theory or fluid approach makes use of the "moment method" of solution of the Boltzmann equation to obtain differential equations which describe low pressure discharges in terms of measurable macroscopic parameters. Solutions are found for the parameters of the discharges in one-dimensional planar, cylindrical, and coaxial geometries for various generation rates and including both the effects of ion-neutral collisions and an applied magnetic field. The results for the one-dimensional collisionless cases are compared with the more exact formulation of Langmuir and found to be in good agreement. In the limit of a small inner conductor, the one-dimensional coaxial solutions are shown to be useful in determining the properties of cylindrical Langmuir probes in the ion collection regime. The results are compared to present collisionless probe theories and found to be in good agreement. The one-dimensional coaxial solutions are then extended to include the effects of collisions and an applied magnetic field on the characteristics of a cylindrical probe. For the most important case of ion generation proportional to electron density, two-dimensional solutions for the parameters of the discharges in a rectangular box, a finite length cylinder, and between finite length concentric coaxial cylinders are found for the first time. Calculated parameters for both the one- and two-dimensional discharges are presented graphically for a number of representative cases and the equations are tabulated and summarized in such a way as to be easily applied to other cases. The theory is also used to describe the behavior of two experimental devices: the so-called oscillating-electron ion source and the Kaufman ion source. Only qualitative agreement between experiment and theory is obtained when the two-dimensional theory is used to approximate the behavior of the oscillating-electron ion source. However, a one-dimensional theory which includes both primary or beam electrons and secondary or Maxwellian electrons is found to give good agreement between theory and experiment for the Kaufman ion source. (auth)

31463 (WERL-3472-6) PLASMA PRODUCTION BY A HIGH-POWER Q-SWITCHED LASER. Quarterly Progress Report No. 1, February 1-April 30, 1967. Engelhardt, A. G. (Westinghouse Research Labs., Pittsburgh, Pa.). Contract AT(30-1)-3472. 6p. Dep. CFSTI.

Development status of the gigawatt laser and its supporting equipment is given. Also, equipment for photon scattering experiments and microwave experiments is discussed. (M.O.W.)

31464 IONIZATION AND EXCITATION IN THE TORCH DISCHARGE. Janca, Jan (Purkyne-Univ., Brno). pp 183-6 of Third Czechoslovak Conference on Electronics and Vacuum Physics, Transactions, Held in Prague on September 23rd-28th, 1965. Paty, Libor (ed.). Prague, Publishing House of the Czechoslovak Academy of Sciences, 1967. (In German).

See CONF-650987.

The torch discharge was excited by 27 MHz in N_2, O_2, He, Ar, Xe, and Ne. An abundance of spectral lines with high potential of excitation up to 20 eV is characteristic for the spectrum of the torch discharge close to electrode surface. The measurement of the electric field strength E close to the electrode gave 3000 V/cm. E in this region is very inhomogeneous. The gain of electron energy between two collisions is about 2 eV, which is sufficient for ionization and excitation. The influence of metastable states for excitation is not important. With the help of the formula for the decrease of electric field strength in the channel of a torch discharge and with the help of the Elenbaas-Heller differential equation it was proved that the temperature of neutral gas in the channel of a torch discharge rises with an increase of excitation frequency. (auth)

31465 SIX-ELECTRODE AC PLASMATRON. Rutberg, F. G.; Kiselev, A. A.; Dolyuk, V. A. (Inst. of Electromechanics, USSR). Teplofiz. Vysok. Temp., 4: 886-7(Nov.-Dec. 1966). (In Russian).

Construction and performance of a six-electrode ac plasmatron for producing a low-temperature plasma are discussed. The plasmatron was tested with argon, nitrogen, hydrogen, and helium gases with continuous operation at 2000 to 4000°K and 1- to 3-atm. pressure. For argon the mean potential between electrodes was 200 V, mean linear currents 150 A, mean energy in the arc 52 kW, gas consumption 30 g/sec, gas temperature at the nozzle 1500°C and test duration of 10 min. (R.V.J.)

Stability of Plasma

Refer also to abstract 31386.

31466 (IPPCZ-50) LOW-FREQUENCY INSTABILITY OF AN INHOMOGENEOUS WEAKLY IONIZED PLASMA IN CROSSED ELECTRIC AND INHOMOGENEOUS MAGNETIC FIELDS. Kopecky, V. (Ceskoslovenska Akademie Ved, Prague. Ustav Fyziky Plasmatu). Mar. 1966. 20p. Dep.

The drift dissipative instability that arises in a weakly ionized inhomogeneous plasma in crossed electric and magnetic fields is discussed. The potential perturbations are studied in the WKB approximation. The critical magnetic field beyond the value of which the plasma is again stable against the perturbations is computed. The effect of the inhomogeneity of the magnetic field modeled by a gravitational field is analyzed and the effect of a magnetic field growing in the direction opposite to that of the plasma density, pointed out. Similar phenomena also arise in the current-convective instability under certain circumstances. (auth)

31467 (MATT-447) INTERCHANGE INSTABILITIES IN IDEAL HYDROMAGNETIC THEORY. Greene, John M.; Johnson, John L. (Princeton Univ., N. J. Plasma Physics Lab.). Feb. 1967. Contract AT(30-1)-1238. 23p. Dep. CFSTI.

Interchange instabilities are examined using an ideal hydromagnetic model so that the nature of the energy sources which can drive the instability is clarified. A generalization of $V''(\psi)$ is determined. (auth)

31468 (NP-tr-1556) TOROIDAL PLASMA EQUILIBRIUM CONFIGURATIONS WITH ZERO TOTAL AZIMUTHAL CURRENT. Meyer, F.; Schmidt, H. U. (Max-Planck-Institut fuer Physik und Astrophysik, Munich (West Germany)). Translated for Culham Lab., Abingdon, Eng., from report CTO-378. 21p. Dep. CFSTI. JCL $2.60 fs, $0.83 mf.

It is shown that it is possible to have toroidal plasma configurations with zero total azimuthal current in equilibrium with an external magnetic field. The current lines may be plane curves, but their planes cannot all intersect one axis. The plasma cross section must have maxima and minima. Azimuthal and meridional cross sections are calculated for certain configurations. It is further shown that, based on the equilibrium conditions for field-free plasmas, a deformable (paper) model network can be constructed which constitutes a true analog of all the equilibrium surfaces. Its application is demonstrated by means of a torus model. (auth)

31469 GROWING WAVE AND INSTABILITY CRITERIA FOR HOT PLASMAS. Derfler, H. (Stanford Univ., Calif.). Phys. Lett., 24A: 763-4(June 19, 1967).

In the original colliding-pole criterion for determining instability types from dispersion relations, the Landau poles had to be selected laboriously. The simple rule can now be proved that only poles colliding through negative wave numbers lead to non-convective instability. (auth)

31470 HIGH-TEMPERATURE PLASMA IN MAGNETIC MIRROR SYSTEMS. Lacina, J. (Inst. of Plasma Physics, Prague). pp 75-83 of Third Czechoslovak Conference on Electronics and Vacuum Physics, Transactions, Held in Prague on September 23rd-28th, 1965. Paty, Libor (ed.). Prague, Publishing House of the Czechoslovak Academy of Sciences, 1967.

See CONF-650987.

The equilibrium distribution function of particles in a phase space pertinent to a collisionless rarefied plasma, placed in an external axially symmetric magnetic field, was derived on the basis of the first integrals of motion. The properties of the plasma are such that the problem consisted of finding a stationary solution of Vlasov's equation for the distribution functions of particles in the phase space. (M.O.W.)

31471 SCATTERING OF MICROWAVES FROM PLASMA SPACE-CHARGE WAVES NEAR THE HARMONICS OF THE ELECTRON GYROFREQUENCY. Anastassiades, A. J.; Marshall, Thomas C. (Columbia Univ., New York). Phys. Rev. Lett., 18: 1117-19(June 19, 1967).

An instability near the harmonics of the electron gyrofrequency has been observed by the method of combination scattering. The instability has been stimulated by a strong external microwave signal propagating along the magnetic field near the cyclotron resonance. (auth)

31472 STATIONARY STATE OF A PLASMA IN A STRONG UHF FIELD. Klima, R. (Inst. of Plasma Physics, Prague). Zh. Tekh. Fiz., 37: 587-8(Mar. 1967). (In Russian).

The conclusions of a paper by Kotsarenko and Fedorchenko (Zh. Tekh. Fiz., 36: 460(1966)) on the stationary state of a plasma in a strong uhf field are questioned. It is asserted that (1) no stationary state of a cold plasma is possible with no mass flow and a non-vanishing average force due to a uhf field "unless one admits the possibility of compression to liquid densities," and (2) the conclusion of the cited paper that the divergence of the electric field vanishes under certain conditions would incorrectly exclude the possibility of longitudinal waves. Attention is called to equation (26) of the cited paper for the electric field that would appear for an unchanged ion density or for a high ion temperature. The author feels that the incorrect conclusions of the cited paper are due to unjustified neglect of the ion motions. (ATD)

Thermonuclear Processes

31473 PRODUCTION OF d–d REACTIONS BY BEAM-PLASMA INTERACTION IN THE STEADY STATE. Alexeff, I.; Jones, W. D.; Neidigh, R. V. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Rev. Lett., 18: 1109-12 (June 19, 1967). (ORNL-P-3005).

An unusual deuterium plasma was produced by a reflex electron beam on the axis of the modified PIG device named Burnout V. Estimated reaction rates are given for the d-d neutrons, tritons, and protons observed on Burnout IV and V. After a description of the Burnout V device and its operation, some of the observations made on IV and V are discussed in detail, covering ion current, spectra, density, deuteron energy, confinement, and impurity effects. (D.L.C.)

Shielding

Refer also to abstracts 30805, 30806, 30808, 31646, 31649, 31734, and 31735.

31474 (ORNL-TM-1892) NUCLEAR REACTION CROSS SECTIONS FOR SPACECRAFT SHIELD DESIGN. Peelle, R. W. (Oak Ridge National Lab., Tenn.). June 16, 1967. Contract W-7405-eng-26. 36p. (CONF-670602-13). Dep. CFSTI.

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif.

Spherical shield geometry is adequate for studying the contribution of nuclear reactions to the dose received by spacecraft occupants. Very high-energy incident protons produce in the shield an essentially isotropic volume source proportional to the angle-integrated production cross section. Protons with range too short too penetrate the shield produce a yield dependent upon the current into the shield, with the importance of cross sections at a given energy being dependent on the incident spectrum and the inverse of the stopping power. Protons of intermediate energy penetrate the shield and stop in the pilot, and so are important for primary rather than for secondary dose. If the shield is not too thick, the secondary dose inside the cavity is rather independent of position in both the high- and low-incident energy limits. Therefore, calculations can be made for the dose at the center of the sphere, where the secondary flux from an isotropic primary flux is equal to that obtained in a modified straight-ahead approximation for monodirectional primary protons incident on a slab. Widely available intranuclear cascade-plus-evaporation calculations give secondary nucleon cross sections which agree fairly well with experiments using incident protons. New data are presented to illustrate that the present model has some limited validity even for incident proton energies as low as 20 MeV. Calculational models are not known to have yielded generally valid cross sections for secondary gamma rays or for secondary neutrons from alpha particles. (auth)

31475 RADIATION SHIELDING UNDER RESTRICTIVE CONDITIONS. Schlums, K.-D. (Technische Hochschule, Brunswick). Kerntechnik, 9: 205-8(May 1967). (In German).

Protective screens for gamma-active nuclides often have high weights. These loads must be borne by the provided building. If the load has to be confined, only sector protection will be possible. Radiological personnel should stay in this sector zone. By positioning radioactive sources near stressed walls, protective screens can be erected additionally in old buildings. Because of absorption in walls and ceilings of the building, the protective shields can be confined in their weight. Some examples demonstrate the efficiency of sector protection. (auth)

Solid-State Physics

Refer also to abstracts 30402, 31687, and 31716.

31476 (BNL-11473) SPIN DENSITIES. Nathans, R. (Brookhaven National Lab., Upton, N. Y.). [nd]. 26p. (CONF-670101-2). Dep. CFSTI.

From American Crystallographic Association Meeting, Atlanta, Ga.

In neutron elastic scattering from magnetic materials the role of the neutron is to act as a probe of the static magnetic fields within the solid material. The various experimental methods that have been used to obtain information concerning the magnetic electron density are discussed. Some of the results of the studies made on various materials are described. (W.D.M.)

31477 (COO-1198-445) PLASTIC RESPONSE OF SOLIDS. Gilman, J. J. (Illinois Univ., Urbana). Apr. 28, 1967. Contract AT(11-1)-1198. 38p. (CONF-670513-4). Dep. CFSTI.

From Colloquium on Dislocation Dynamics Conference, Seattle, Wash.

Past developments of the micro-dynamical description of plastic flow are outlined, and the successes of the theory are mentioned. Some extensions in scope are suggested and discussed. These include: application to polymeric solids, collective dislocation behavior, and dynamics of precipitation hardening. The difficulty that the flowing state differs from the post-flowing state is emphasized. It is proposed that dislocation lines exist in non-crystalline solids and provide a convenient description for local shear correlations. The possibility that flutter is induced in moving dislocations by turbulent phonon-gas flow is considered. Finally, an atomic model for dislocation mobility in covalent crystals is presented. (auth)

31478 (ORNL-tr-1708) ENERGY AND ANGULAR DISTRIBUTION OF SECONDARY IONS EMITTED BY ALUMINUM AND COPPER. Castaing, Raymond; Hennequin, Jean-Francois. Translated for Oak Ridge National Lab., Tenn., from Compt. Rend., Ser. A and B, 262: 1008-11(Apr. 1966). 7p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

The secondary ions emitted by aluminum and copper under bombardment with 8-keV argon ions have very different energy and space distributions than those observed under similar conditions with neutral ejected atoms. The intervention of focalized collision chains, which are predominant in the ejection of neutral atoms, does not seem to be evident in the emission of ions. (auth)

31479 SCATTERING OF COLD NEUTRONS IN AMMONIUM CARBONATE, AMMONIUM CITRATE, AND AMMONIUM ACETATE. Myers, Vernon W. (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 46: 4034-5(May 15, 1967).

Neutron-energy-gain spectra have been measured in $(NH_4)_2CO_3$, $(NH_4)_2HC_6H_5O_7$, and $NH_4C_2H_3O_2$ at 20°C using the Brookhaven slow-chopper facility. Each spectrum exhibits two peaks that are characteristic of optical modes. The spectra of ammonium carbonate and ammonium citrate are similar to those of the body-centered-cubic lattice phase of the ammonium halides in which the ammonium ion has torsional and translational optical vibrations. (auth)

31480 BIREFRINGENCE OF HEXAGONAL ^{4}He AT VARIOUS DENSITIES. Vos, J. E.; Kingma, R. Veenenga; Van Der Gaag, F. J.; Blaisse, B. S. (Laboratorium voor Technische Natuurkunde, Delft, Netherlands). Phys. Lett., 24A: 738(June 19, 1967).

Measurements were made of the birefringence of hexagonal helium-4 at four different densities, corresponding to pressures of 30 to 1050 atm near the melting line. The averages of selected values of $n_s - n_0$ for a number of crystals, as well as the standard deviation, σ, of these values are given. (M.D.W.)

31481 POSSIBILITY OF MEASURING THE THERMAL VIBRATION SPECTRUM g(ω) USING COHERENT INELASTIC NEUTRON SCATTERING FROM A POLYCRYSTALLINE SAMPLE. Bredov, M. M.; Kotov, B. A.; Okuneva, N. M.; Oskotskii, V. S.; Shakh-Budagov, A. L. (Inst. of Semiconductors, Leningrad). Soviet Phys.-Solid State (Engl. Transl.), 9: 214-18(July 1967).

Translated from Fiz. Tverd. Tela, 9: 287-93(Jan. 1967).

Consideration is given to the possibility of a direct determination of the phonon frequency distribution function by inelastic scattering of cold neutrons from polycrystalline samples. The results derived are checked experimentally by applying the method to aluminum. (auth)

31482 PHOTOCHEMICAL TRANSFORMATIONS OF RADIOPHOSPHORUS IN SINGLE CRYSTALS OF POTASSIUM CHLO-

RIDE. Bogdanov, R. V.; Murin, A. N. (Leningrad State Univ.). Soviet Phys.-Solid State (Engl. Transl.), 9: 180-6(July 1967).

Translated from Fiz. Tverd. Tela, 9: 243-52(Jan. 1967).

A study was made of the effect of monochromatic and white light on the chemical state of recoil atoms of phosphorus in potassium chloride. Models of the chemical forms are proposed and an interpretation is given of the photochemical oxidation and reduction of radiophosphorus in KCl crystals. (auth)

31483 COALESCENCE OF F CENTERS IN PHOTOCHEMICALLY COLORED NaCl AND KCl CRYSTALS CONTAINING ANION IMPURITIES. Tsal, N. A.; Pashkovskii, M. V.; Didyk, R. I. (Lvov State Univ.). Soviet Phys.-Solid State (Engl. Transl.), 9: 175-9(July 1967).

Translated from Fiz. Tverd. Tela, 9: 237-42(Jan. 1967).

A study was made of the optical absorption spectra of γ-irradiated single crystals of NaCl and KCl containing anion oxygen-bearing impurities and cation impurities ($CaCl_2$, $SrCl_2$). The total ^{60}Co γ-ray dose ranged from 5.0×10^7 R to 1.0×10^9 R and the dose rate was higher than 2000 R/sec. When the dose was not less than 1.0×10^8 R, the NaCl crystals containing anion impurities exhibited an intense colloidal-type band at 600 nm. Heating these crystals to 200°C not only greatly reduced the intensity of this band, but also shifted the absorption maximum to 560 nm. Irradiation of KCl–OH crystals produced a weak colloidal band and a broad strong M band. An inverse relationship was noted between the stability of F centers at room temperature and the concentration of oxygen-bearing impurities. (auth)

31484 FORMATION OF STRUCTURE DEFECTS DURING LOW-TEMPERATURE IRRADIATION OF INDIUM ANTIMONIDE WITH X RAYS. Chelustka, B.; Khansevarov, R. Yu.; Mashovets, T. V.; Kozlova, I. R. (Ioffe Inst. of Physics and Tech., Leningrad). Soviet Phys.-Solid State (Engl. Transl.), 9: 253-4 (July 1967).

Translated from Fiz. Tverd. Tela, 9: 338-40(Jan. 1967).

In an experiment on radioinduced structure defects, n- and p-type indium antimonides, having initial electron and hole densities of (2 to 8) $\times 10^{13}$ and (0.7 to 1.3) $\times 10^{14}$ cm^{-3}, respectively, were irradiated with x rays from a tungsten anticathode. The resistivity and Hall coefficient of the samples were measured before irradiation and at various stages during irradiation. Results indicate that the parameters of the n-type samples were not affected by such irradiation. The p-type samples exhibited considerable changes in the carrier density, resistivity, and mobility. The fact that structure defects are formed by x-ray bombardment only in p-type indium antimonide is discussed. (J.H.M.)

31485 3.9-μ PHOTOCONDUCTIVITY BAND IN NEUTRON-IRRADIATED p-TYPE SILICON. Cheng, L. J. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Lett., 24A: 729-31 (June 19, 1967).

The 3.9-μ radiation-induced photoconductivity band observed in p-type Si was studied by a technique employing uniaxial stress and polarized light. It was possible to correlate the photoconductivity band with the divacancy. Also the results indicate an explanation for the band shape of the photoconductivity. (auth)

31486 MECHANISM OF FORMATION AND DISINTEGRATION OF BINARY QUENCHING CENTERS IN URANYL SALTS. Tolstoi, N. A.; Abramova, I. N.; Abramov, A. P. Opt. Spectros. (USSR) (Engl. Transl.), 22: 269-70(Mar. 1967).

Translated from Opt. Spektrosk., 22: 497-9(Mar. 1967).

The mechanisms of radioinduced luminescence which includes the formation and disintegration of binary quenching centers in cesium uranyl nitrate at –196°C are discussed. (B.G.D.)

31487 STUDY OF THE OPTICAL AND EPR SPECTRA OF GAMMA-IRRADIATED PHOSPHATE GLASSES. Karapetyan, G. O.; Sherstyuk, A. I.; Yudin, D. M. Opt. Spectros. (USSR) (Engl. Transl.), 22: 239-42(Mar. 1967).

Translated from Opt. Spektrosk., 22: 443-9(Mar. 1967).

An analysis of the optical and paramagnetic spectra of PO_3^{2-} and $:PO_3^{3-}$ complexes in zinc metaphosphate glasses and exposed to γ radiation from ^{60}Co is presented. (auth)

31488 CHANNELING IN GOLD. Whitton, J. L. (Chalk River Nuclear Labs., Ont.). Can. J. Phys., 45: 1947-57(May 1967).

The penetration of radioactive ^{133}Xe and ^{198}Au ions into oriented monocrystals of gold has been measured in the energy range 20 to 80 keV using an electrochemical sectioning technique. Channeling along low-index directions was observed to increase in the order ⟨111⟩, ⟨100⟩, ⟨112⟩, ⟨110⟩, in agreement with theory and with the previous experimentally determined order in other fcc lattices such as copper and aluminium. Two distinct differences in the channeling behavior of ions in gold compared to tungsten are noted: (1) a much smaller fraction of the incident ions remains channeled and (2) the maximum range of the channeled ions is much larger than in tungsten. These differences in behavior are ascribed to the increased multiple scattering due to the higher rms vibrational amplitude and the lower electronic stopping power in gold. "Supertails" (interstitial diffusion processes) have not been observed. Depth distributions of various other ions at a constant velocity show essentially no dependence on mass. (auth)

31489 CONTRIBUTION TO THE THEORY OF KINETIC PHENOMENA IN AN ELECTRON–PHONON SYSTEM. Gvozdovskii, I. V.; Shenderovskii, V. A. (Chernovtsi State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 2, 116-20(1967). (In Russian).

The electric conductivity, thermal emf, and thermal conductivity of a nondegenerate electron gas are calculated with allowance for the scattering of the electrons by optical and acoustic crystal-lattice vibrations. The determination of the kinetic coefficient is reduced to a solution of a finite-difference equation. Since the evaluation of the appropriate integrals is a difficult task, the final results are confined to very high and very low temperatures, and it is shown that the Wiedemann–Franz law is satisfied in these two cases. (ATD)

31490 THERMAL STIMULATION OF IRRADIATED LITHIUM FLUORIDE CRYSTALS. Davitashvili, T. Sh.; Politov, N. G. Opt. Spectros., 22: 167-8(Feb. 1967).

Translated from Opt. Spektros., 22: 309-11(Feb. 1967).

Carefully annealed LiF crystals were subjected to cyclic irradiation as follows: the first cycle was in a reactor or gamma circuit; the second cycle was in a gamma circuit (7×10^5 R); the third was in a reactor (6×10^{14} n/cm^2); and the fourth was again in a reactor (6×10^{14} n/cm^2). Thermal stimulation curves were measured after each cycle. In these experiments the magnitude of the neutron flux or the gamma dose was varied over a wide range only in the first cycle of irradiation. (W.D.M.)

31491 F BAND IN X- AND ELECTRON-IRRADIATED CaF_2. Patterson, David A.; Fuller, Robert G. (Naval Research Lab., Washington, D. C.). Phys. Rev. Lett., 18: 1123-4(June 19, 1967).

After a discussion of the spectra of CaF_2:Mn crystals irradiated at liquid-nitrogen and room temperatures, results are reported of a pulsed electron irradiation (15 MeV, 0.4 μsec) of a CaF_2 crystal at room temperature. The three bands characteristic of low-temperature irradiation decay away rapidly, but no evidence of a transient F band was found at times longer than 0.2 μsec. A possible reason is discussed. (D.L.C.)

31492 DIFFRACTION OF POLARIZED NEUTRONS BY A HELIMAGNETIC [SUBSTANCE]. Herpin, Andre (CEN, Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. A and B, 264: 840-2(Mar. 13, 1967). (In French).

A supplementary term in the cross section formula of polarized neutrons when the magnetic moments are not collinear is shown. This theory is applied to a helimagnetic substance. The possibility of determining the absolute magnetic configurations is deduced. (tr-auth)

31493 QUASI-PERIODIC DISTRIBUTION OF FAULTS IN BeO IRRADIATED WITH NEUTRONS. Belbeoch, Bella; Borensztajn, Jacques; Roulliay, Monique; Tournarie, Max (CEN, Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. A and B, 264: 883-6(Mar. 13, 1967). (In French).

A quasi-periodic distribution of interstitial plane faults makes it possible to explain the x-ray-diffraction diagrams of BeO monocrystals irradiated with neutrons. (tr-auth)

31494 CRYSTALLOGRAPHIC STUDY AND MAGNETIC PROPERTIES OF MIXED GARNETS OF Ho AND CERIC EARTHS. Villers, Gerard; Paulus, Max; Loriers, Jean; Clerc, Francoise (CNRS, Bellevue, France). Compt. Rend., Ser. A and B, 264: 737-40(Mar. 6, 1967). (In French).

A study was made of the group of substitution compounds with the general formula $5Fe_2O_3 \cdot xLn_2O_3 \cdot (3-x)Ho_2O_3$ with Ln = La, Pr, Nd, Sm, or Eu. The limits of the regions of existence and values of the crystalline lattice parameters were given. The magnetic properties were examined. An interpretation was given of the experimental results. (tr-auth)

31495 TEORIYA RASSEYANIYA RENTGENOVSKIKH LUCHEI I TEPLOVYKH NEITRONOV REAL'NYMI KRISTALLAMI. (Theory of X-Ray and Thermal Neutron Scattering by Real Crystals). Krivoglaz, M. A. Moscow, Izdatel'stvo Nauka, 1967. 336p.

A systematic account is given of the applications of x-ray and neutron scattering to static inhomogeneities and various-type crystal defects. Parts I and II are devoted to elastic and inelastic scatterings, respectively. (R.V.J.)

Theoretical Physics

Refer also to abstracts 31155, 31156, 31161, 31545, and 31879.

31496 (AD-629091) THE GROUND-STATE THREE-BODY CORRELATION FUNCTION IN A DILUTE BOSON GAS WITH HARD-SPHERE INTERACTION. Scientific Report No. 41. Smith, Vedene H. Jr. (Uppsala Univ. (Sweden)). Apr. 15, 1965. Contract AF 61(052)-701. 11p. CFSTI.

The three-body correlation function for the ground state of a boson gas with hard sphere interactions is evaluated in the approximation of pair excitations. The evaluation is made using both the formalism of second quantization and the cluster expansion method in configuration space. The result is compared with a previous calculation using the same wave function. The behaviour of the correlation function is discussed. (auth)

31497 (AD-633654) LINKED CLUSTER THEOREM AND THE GREEN'S FUNCTION EQUATIONS OF MOTION FOR A MANY FERMION SYSTEM. Kobe, Donald H. (Uppsala Univ., (Sweden)). Dec. 1, 1965. Contract AF 61(052)-874. 48p. (ARL-66-0097). CFSTI.

The equations of motion for the general many-time causal Green's functions for a fermion system are iterated and shown not to lead to unlinked graphs, which is a general proof of the linked cluster theorem. An explicit expression is obtained for the perturbation expansion of an arbitrary Green's function which is applied to the one and two particle Green's functions. By connecting lines systematically in a set of diagrams obtained from the equations of motion, the usual topologically different linked graphs and rules are generated. (auth)

31498 (AD-636063) EQUATIONS OF MOTION OF A DYNAMICAL SYSTEM OF PARTICLES. Harvey, A. L. (Queens Coll., New York. Dept. of Physics). July 1, 1966. Contract Nonr(G)-00036-66). 8p. (TR-1). CFSTI.

The equations of motion of a dynamical system are discussed in terms of the initial data. The point of view emphasized is that the initial data are explicitly time dependent constants of the motion, knowledge of which constitutes, implicitly, a complete solution of the equations. A general algorithm for constructing the set of constants in this form and from it the complete solution is given. The algorithm provides a complete, formal solution for the dynamical equations in terms of the Hamiltonian function. (auth)

31499 THEORY OF MEASUREMENT OF INCOMPATIBLE OBSERVABLES IN QUANTUM MECHANICS. Prugovecki, Eduard (Univ. of Alberta, Edmonton). Can. J. Phys., 45: 2173-2219(June 1967).

The empirical meaning of the simultaneity of measurement of several observables is carefully analyzed. General criteria sufficient to guarantee the internal consistency of a framework including simultaneous measurements of incompatible observables are put forward. The case is illustrated with the example of simultaneous measurements of position and momenta of particles in quantum mechanics. It is pointed out that, in general, the outcome of measurements of incompatible observables cannot be described statistically by means of the probability measures of mathematical statistics, which have primarily been introduced only with compatible observables in mind. The concept of complex probability measure is put forward. A generalization of the current interpretation of quantum mechanics is proposed that would also include the case of incompatible observables, by taking advantage of the concept of complex probability measure. (auth)

31500 COMMENT ON THE POINT TRANSFORMATIONS IN QUANTUM THEORY. Langenberg, Manfred; Steinwedel, Helmut (Univ., Wuerzburg, Ger.). Z. Phys., 202: 118-24(1967). (In German).

It is shown that point transformations in quantum mechanics are generally achieved by isometric transformations in Hilbert space. (auth)

31501 LORENTZ PRINCIPLE AND THE GENERAL THEORY OF RELATIVITY. IV. Janossy, L. (Central Research Inst. of Physics, Budapest). Acta Phys. Acad. Sci. Hung., 23: 53-65 (1967).

It is shown that the Lorentz transformation as defined in Parts I-III is ambiguous regarding terms of higher order. The ambiguity cannot be eliminated mathematically; it is shown that this ambiguity reflects upon the fact, that the behavior of an extended physical system in a gravitational field is affected by its inner structure. (auth)

31502 HUBBLE'S EXPANSION IN VECTORS FORMED BY Δ TENSORS. Mehra, A. L. (Univ. of Jodhpur, India). Acta Phys. Acad. Sci. Hung., 23: 125-9(1967).

The vectors are evaluated for some nonstatic cosmological models. It is concluded that the three components (x^1, x^2, x^3) of the gravitational field force are along the space axes and the fourth component (x^4) corresponds to Hubble's expansion. (W.D.M.)

31503 NOTE ON THE ZERO-FREQUENCY POLE IN GREEN'S FUNCTIONS. Fernandez, J. F.; Gersch, H. A. (Georgia Inst. of Tech., Atlanta). Proc. Phys. Soc. (London), 91: 505-6(June 1967).

A simple method to treat consistently the zero-frequency pole in the spectral representation of the correlation functions in equilibrium statistical mechanics is presented. (auth)

31504 EXACT THOMAS-FERMI METHOD IN PERTURBATION THEORY. Stoddart, J. C.; March, N. H. (Univ. of Sheffield, Eng.). Proc. Roy. Soc. (London), Ser. A, 299: 279-86(June 14, 1967).

A variational principle is constructed which leads directly to the March-Murray perturbation series relating the particle density $\rho(r)$ with the one-body potential $V(r)$ in an electron gas. An explicit, though perturbative, form for the Hohenberg-Kohn universal functional, which is essentially the kinetic energy density, is thereby obtained. When the spatial variations of density and potential are slow, the usual Thomas-Fermi ρ^{5} relation between kinetic energy density and particle density is regained. The present approach also leads to a systematic formulation of the gradient expansion of the kinetic energy density. (auth)

31505 NEW METHOD OF EXPANSION IN THE QUANTUM MANY-BODY PROBLEM. III. THE DENSITY FIELD. Sherrington, D. (Univ. of Manchester, Eng.). Proc. Phys. Soc. (London), 91: 265-72(June 1967).

In a discussion of the quantum dynamics of a nonrelativistic many-particle system it is shown how a two-body interaction, quartic in the field operators, may be replaced by an interaction with an auxiliary density-like field. An extension of the procedure of Edwards and Sherrington for expanding in terms of correlations about the state of maximal quantum randomness is applied to the coupled system to give the density correlations and excitations as well as the corresponding single-particle quantities. As an example, an explicit expression for the density excitations is obtained in terms of the quasi-particle energies, for the case in which quasi particles exist as well-defined modes of single-particle excitation. (auth)

31506 BOUND STATES OF A CHARGED PARTICLE IN A DIPOLE FIELD. Crawford, O. H. (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 91: 279-84(June 1967).

A general study was made of the bound states of a charged particle in a static field which behaves as the dipole form asymptotically. When the field is that of either a point dipole plus a sufficiently repulsive spherical core, or a finite dipole, the existence of bound states of the charged particle depends only on the value of the reduced dipole moment K. It is shown that each symmetry class of states has its own threshold value of K such that states of that symmetry exist if, and only if, K exceeds the critical minimum. There is an infinite number of states of given symmetry, when there are any. Critical values of $K < 100$ are calculated. When the potential has an arbitrary form at short range (but still has the dipole form at long range), the situation remains much the same, with the exception that sufficient attraction at short range will allow some states to exist for any value of the dipole moment. (auth)

31507 THIRD-ORDER OF THE NON-RELATIVISTIC APPROXIMATION OF THE DIRAC ELECTRON THEORY. Garszcynski, F.; Hanus, W. (Copernicus Univ., Torun, Poland). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 15: 205-9 (1967).

The third-order nonrelativistic approximation of the Dirac electron theory was derived by the method involving elimination of small spinor components. The procedure, with a non-Hermitian term of the Hamiltonian, was carried out in the second order of approximation. (tr-auth)

31508 DYNAMICS OF THE ISING CHAIN. I. Bialynicki-Birula, I.; Piasecki, J. (Univ. of Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 15: 211-16(1967).

The one- and two-particle time-dependent Green functions in the Ising model at non-zero temperature were calculated. For expediency, the Ising model was treated in terms of a many-fermion system of creation and annihilation operators. (tr-auth)

31509 EXTERNAL STATIONARY SPACE-TIME: ENERGY AND EUCLIDIAN BEHAVIOR. Deser, Stanley (Institut Henri Poincare, Paris. Brandeis Univ., Waltham, Mass.). Compt. Rend., Ser. A and B, 264: 805-8(May 3, 1967). (In French).

An alternative of a classic theorem of Lichnerowicz was demonstrated; all stationary, external, complete, and asymptotically flat space-time is locally euclidian. In place of the metric on the quotient space, the dual demonstration, the Cauchy data on the hypersurface $x^0 = Cte$, was considered. This releases the physical role played by the energy of the field. It is shown that it is annulled first, and then that space-time is euclidian. (J.S.R.)

31510 m-DIMENSIONAL INTERPRETATION OF THE n-DIMENSIONAL EINSTEIN EQUATION. Juan, Henri (Faculte

des Sciences, Marseille). Compt. Rend., Ser. A and B, 264: 541-3(Mar. 13, 1967). (In French).

A G group of total isometries with p parameters operates on a Riemann variety with n-dimensions U; the ensemble $\hat{U}$ of the G orbits constitutes a quotient variety with $n - p = m$ dimensions; the Einstein equation is assumed valid on U and an m-dimensional interpretation on $\hat{U}$ is constructed. (tr-auth)

31511 CALCULATION AND UTILIZATION OF THE MOMENTS OF THE DISTRIBUTION FUNCTION OF A PERFECT FLUID. Pichon, Guy (Univ., Tours, France). Compt. Rend., Ser. A and B, 264: 544-7(Mar. 13, 1967). (In French).

The general expression of the moments of the distribution function is indicated and used in studies of the orthogonal polynomials on the Minkowski hyperboloid. (tr-auth)

31512 ENERGY VARIATION, BY GRAVITATIONAL RADIATION, OF A TWO-BODY SYSTEM IN A MINKOWSKI THEORY OF GRAVITATION. Signore-Poyet, Monique. Compt. Rend., Ser. A and B, 264: 829-32(Mar. 13, 1967). (In French).

The effects of the reaction of gravitational radiation on the movement of sources has been studied previously. In general relativity the conclusions deduced of the E. I. H. method lead to diverse restrictions. According to the case there are gains or losses of energy. Havas and Smith have undertaken this question in the study of the two-body problem. By using the results obtained by a method applicable to fast movements (fast approximation method) they have found that two equal masses in quasi-circular motion, describe a spiral being enlarged in time: the two-body system gains energy. The developments of Havas and Smith are based on a Lorentz-invariant approximation method which can be criticized within the framework of the Einstein theory. Recently, Schmutzer and Roemhild (independently) have repeated the Havas and Smith work but have utilized an invariant approximation method in a general transformation of coordinates with each order of approximation. Nevertheless, the two-body problem can not be studied sufficiently by this method. It is proposed to study the variation of energy of a two-body system due to the gravitational radiation in the framework of a Minkowski theory of gravitation. (tr-auth)

31513 MATTER–RADIATION INTERACTION: SEMIRELATIVISTIC STATISTICAL DESCRIPTION. BASIC EQUATIONS. de Jouvenel, Foulques; Quemada, Daniel (Univ., Paris, Orsay, France). Compt. Rend., Ser. A and B, 264: 833-5(Mar. 13, 1967). (In French).

The semirelativistic approximation (the second order in v/c) of a statistical theory of the matter–radiation interaction was studied. This relativistic statistic is based on a description which, contrary to usual theories, does not introduce canonical variables of the field but treats the field as a property of the particles and presents the advantage of being renormalized from the beginning. The general formalism is given. (tr-auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstract 31473.

Electromagnetic

31514 (AD-635061) DIRECT SEARCH FOR THE C-VIOLATING DECAY 'NEUTRAL-ETA TO NEUTRAL-PION + POSITRON + ELECTRON'. Bingham, H. H.; Michael, W.; Baglin, C.; Bezaguet, A.; Degrange, B. (California Univ., Berkeley. Cosmic Ray Group). June 1966. Contract Nonr-3565(13). 19p. (ONR-1-1966). CFSTI.

No examples of the decay $\eta^0 \rightarrow \pi^0 + e^+ + e^-$ were found in a sample of film containing 287 detected $\eta^0 \rightarrow \pi^0 + \pi^+ + \pi^-$. The film was taken with the heavy liquid bubble chamber exposed to 950 MeV/c negative-pions. With 90% confidence the branching ratio to $\eta^0 \rightarrow \pi^0 + e^+ + e^-$ is less than 0.23% of all neutral-eta baron decays. (auth)

31515 (DESY-67/18) THE CHARGE FORM FACTOR OF THE PROTON AT A MOMENTUM TRANSFER OF 75 F^{-2}. Bartel, W.; Dudelzak, B.; Krehbiel, H.; McElroy, J. M.; Meyer-Berkhout, U.; Morrison, R. J.; Nguyen-Ngoc, H.; Schmidt, W.; Weber, G. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany). Hamburg Univ. (West Germany). II. Institut fuer Experimentalphysik). May 1967. 8p. Dep.

Cross sections for elastic electron-proton scattering were measured at $q^2 = 75\ f^{-2}$ in order to distinguish between the proton charge form factor $G_E = 0$ and $G_E = G_{M/\mu}$ at this momentum transfer. The measurement was performed using the same apparatus as in a previous experiment. The experimental data were found to be consistent with the Rosenbluth formula within the limits of error. The proton charge form factor was found to be different from zero at $q^2 = 75\ f^{-2}$ and consistent with the scaling law $G_E = G_{M/\mu}$. (L.B.S.)

31516 PHOTOPRODUCTION OF SINGLE CHARGED PIONS FROM DEUTERIUM AND HYDROGEN. Bar-Yam, Z. (Southeastern Massachusetts Technological Inst., North Dartmouth); de Pagter, J.; Hoenig, M. M.; Kern, W.; Luckey, D.; Osborne, L. S. Phys. Rev. Lett., 19: 40-2(July 3, 1967).

Differential cross sections for the photoproduction of single charged pions from deuterium and hydrogen were measured at pion center-of-mass angles between 30 and 90° and at photon energies between 3.0 and 3.7 GeV. The ratio of π^- to π^+ cross sections from deuterium is found to be appreciably smaller than 1. (auth)

31517 PHOTODISINTEGRATION OF THE DEUTERON FROM 100 TO 420 MeV. Kose, R. (Univ., Bonn); Paul, W.; Stockhorst, K.; Kissler, K. H. Z. Phys., 202: 364-82(1967).

The differential cross section of the photodisintegration of the deuteron was measured for photon lab. energies from 100 to 420 MeV. The protons were detected with a range telescope. Competing backgrounds due to pion photoproduction were eliminated by detecting the coincident neutrons with a liquid scintillation counter. (auth)

31518 FURTHER RESULTS IN DIRECT SEARCH FOR C VIOLATING DECAY MODE $\eta^0 \rightarrow \pi^0 e^+ e^-$. Baglin, C. (Ecole Polytechnique, Paris); Bezaguet, A.; Degrange, B.; Jacquet, F.; Musset, P.; Nguyen-Khac, N.; Nihoul-Boutang, G.; Bingham, H. H.; Michael, W. Phys. Lett., 24B: 637-8(June 12, 1967).

No example of this decay was found in a sample of film containing 752 $\eta^0 \rightarrow \pi^0\pi^+\pi^-$ with π^0 detected. The pictures were taken with the heavy liquid bubble chamber exposed to a 950 MeV/c π^- beam at Saclay. With 90% of confidence the decay fraction is less than 0.9×10^{-3} of all η^0 decays. (auth)

31519 ARE PHOTON-PHOTON SCATTERING EXPERIMENTS FEASIBLE? Csonka, P. L. (CERN, Geneva). Phys. Lett., 24B: 625-8(June 12, 1967).

The significance of photon-photon scattering experiments and the experimental possibilities are discussed. The following techniques are mentioned: laser beams clashed with high energy γ-ray beams, flash X-ray machines, nuclear explosions, synchrotron radiation, clashing of two γ-ray beams. (auth)

31520 MUON. Southworth, B. (CERN, Geneva). Nucleus (Paris), 8: 1-5(1967). (In French).

Experiments are underway at CERN to measure with great precision the abnormal magnetic moment of the muon. Preliminary tests have already confirmed the conclusions of a previous experiment known under the name of "g minus 2". The details of this experiment are described. (J.S.R.)

31521 MEASUREMENT OF THE Σ^+ MAGNETIC MOMENT USING THE REACTION $\gamma + p \rightarrow \Sigma^+ + K^0$ NEAR THRESHOLD. Sullivan, C. R.; McInturff, A. D.; Kotelchuck, D.; Roos, C. E. (Vanderbilt Univ., Nashville). Phys. Rev. Lett., 18: 1163-6 (June 19, 1967).

The sample of 51 high-information Σp events has a mean rotation of 32° percent and gives no evidence of bias; it yields $\mu_{\Sigma^+} = +3.0 + 1.2\ \mu_N$ and $\alpha\bar{P} = +0.85 + 0.25$ in the direction $\hat{P}_\gamma \times \hat{P}_\Sigma$. All magnetic field components along the path of each Σ^+ were considered. The use of nuclear emulsion enables one to include the effects of the Σp cm angle on detection efficiency, and thereby on the calculated value of μ_{Σ^+}. (auth)

31522 DETERMINATION OF THE Σ^+ MAGNETIC MOMENT USING THE REACTION $K^- + p \rightarrow \Sigma^+ + \pi^-$ AT 1.15 GeV/c. Kotelchuck, D.; Goza, E. R.; Sullivan, C. R.; Roos, C. E. (Vanderbilt Univ., Nashville). Phys. Rev. Lett., 18: 1166-70(June 19, 1967).

A sample of 52 Σp decays satisfying hydrogen-like production kinematics yields $\mu_{\Sigma^+} = +3.5 \pm 1.5\ \mu_N$ and $\alpha\bar{P} = -0.69 \pm 0.15$ relative to $\hat{P}_K \times \hat{P}_\Sigma$. The effect of all magnetic field components along the Σ^+ path was included, as well as that of the cm decay angle on detection efficiency. The measurement of μ_{Σ^+} can be averaged with an earlier result to give $\mu_{\Sigma^+} = +3.2 \pm 0.9\ \mu_N$, consistent with the prediction by SU(3). (auth)

Weak

31523 SEARCH FOR LONG LIVED Λ^0 HYPERONS. Anikina, M.; Vardenga, G.; Zhuravleva, M.; Kotlyarevskii, D.; Lukstyn'sh, Yu.; Okonov, E.; Takhtamyshev, G.; Khorozov, S.; Chkhaidze, L. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 1042-4(May 1967). (In Russian).

A search was made for the long lived Λ^0 particles under conditions like those when the decay $K_L^0 \rightarrow \pi^+\pi^-$ was observed. If the assumption of the identical character of nonexponentiality in the K_L^0 and Λ^0 decays is made, the number of long lived Λ^0 hyperon decays is expected to be $N_{\Lambda^0} \simeq 10$. The experimental value is found to be $N_{\Lambda^0} \leq 1$. The comparison of these two values makes a strong presumption against the models which explain the decay $K_L^0 \rightarrow \pi^+\pi^-$ due to nonexponentiality in the decays of nonstable particles. (auth)

Strong (Baryon-Induced)

31524 (COO-1537-1) ANNUAL PROGRESS REPORT IN HIGH ENERGY PHYSICS [JUNE 1966-JUNE 1967]. Libby, Leona Marshall (Colorado Univ., Boulder. Dept. of Physics and Astrophysics). Contract AT(11-1)-1537. 12p. Dep. CFSTI.

The work in progress at the University of Colorado includes film measuring and computation. Several experiments now in progress are briefly described. These are $K^- + p$, $\pi^- + p$, $\bar{p} + p$, $K^- + d$ interactions, and world analysis of the lambda magnetic moment. Optical model computations, the application of a computerized dirac equation to elastic diffraction patterns for $\bar{p} + p$, $K^- + p$, and $\pi + p$ interactions, and the production of free radicals and radioactive species in planetary atmospheres by solar radiation and high particles in cosmic rays are also mentioned. (J.F.P.)

31525 (UCR-P107-46) [HIGH-ENERGY PHYSICS]. Annual Report. Barkas, Walter H. (California Univ., Riverside). May 1967. Contract AT(11-1)-34. 36p. Dep. CFSTI.

Work that was carried out in several areas of high energy physics is described. Visual techniques are used. For the study of the three-pion decay of the K^+ meson, bubble chamber and emulsion methods are used to complement each other, particularly for the τ' mode. Several separate bubble chamber experiments in π^+p, $\bar{p}p$ and K^-p interactions are also described, and the large effort devoted to computer reprogramming for the data analysis indicated. Two emulsion research projects are also described which have for their purpose the study of electromagnetic processes induced by 16-BeV electrons and the study of hypernuclei by K^- mesons. For the latter work high speed computer methods have been successfully applied to the analysis of the product hypernuclei. These programs of work have not been under way long enough for the main results yet to be available, but some preliminary data were published and several reports on data analysis and related subjects were prepared. (auth)

31526 ELASTIC SCATTERING OF 2.7 GeV/c ANTIPROTONS ON PROTONS. Domingo, V.; Fisher, G. P.; Libby, L. Marshall; Sears, R. (Univ. of Colorado, Boulder). Phys. Lett., 24B: 642-4(June 12, 1967).

The differential elastic scattering cross section for 2.7 GeV/c antiprotons on protons was studied using film from the hydrogen bubble chamber. The diffraction pattern based on a total sample of 7300 events shows a sharp forward maximum, a first diffraction minimum, and a second maximum. The forward diffraction peak is fitted by $(d\sigma/dt)_{elastic} = 325 \pm 6$ mb/(GeV/c)^2] exp[-13.3 ± 0.2(GeV/c)$^{-2}$t] and the total elastic cross section is found to be 25.6 ± 0.6 mb. The first and second diffraction peaks are fitted by the optical model formula for a "black" disc, $d\sigma/dt \sim J_1(2k\ R \sin \frac{1}{2}\theta)/(2k\ R \sin \frac{1}{2}\theta)]^2\ (1 + a \cos \theta)^2$ where R = 1.2 fm and a = −5. (auth)

Strong (Meson-Induced)

Refer also to abstract 31524.

31527 (JINR-P1-3285) UGLOVAYA KORRELYATSIYA γ-KVANTOV, OBRAZUYUSHCHIKHSYA PRI OSTANOVKE π⁻-MEZONOV V VODORODE. (Angular Correlation of γ-Quanta Produced by the Stopping of Negative Pions in Hydrogen). Vasilevskii, I. M.; Vishnyakov, V. V.; Dunaitsev, A. F.; Prokoshkin, Yu. D.; Rykalin, V. I.; Tyapkin, A. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 67p. (In Russian). Dep.

The angular correlation of γ-quanta emitted in the capture of stopped mesons (π^-) in hydrogen is measured. The measurements were performed by using the scintillation and gas-discharge counters hodoscope. The value of mass difference of charged and neutral mesons (π^-) was found to be (4.6034 ± 0.0052) MeV/c^2. The upper probability limit of the production of the second neutral meson (π), which has a mass in the range of 135 to 138 MeV/c^2, was determined. (auth)

31528 (JINR-P1-3313) NEKOTORYE METODICHESKIE VOPROSY ISSLEDOVANIYA REAKTSII $K^+p \rightarrow KN_\pi$ PRI IMPUL'SE 3,5 GeV/C V 81 CM KHIDKOVODORODNOI PUZYR'KOVOI KAMERE TSERN'a. (Some Methodical Problems of $K^+p \rightarrow KN_\pi$ Reaction Investigation at 3.5 GeV/c in the CERN 81 cm Liquid Hydrogen Bubble Chamber). Moissev, A. M.; Yarba, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1967. 36p. (In Russian). Dep.

The reactions $K^+p \rightarrow KN_\pi$ at the primary K^+-meson momentum of 3.5 GeV/c were investigated on the photographs of the 81-cm liquid hydrogen bubble chamber. The procedure of data processing used and the system of programs of the track chamber division are described. The problems of the event selection and inclusion of the ambiguously interpreted events into statistics are also discussed. (auth)

31529 (TID-23843) MULTIPLE PION PRODUCTION IN 5.5 GeV/c π^-p INTERACTIONS. Bomse, Frederick; Borenstein, Samuel; Brucker, E. Byerly; (and others) (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics). [1965]. 33p. Dep. CFSTI.

About two thousand six prong events and 130 eight prong events from an exposure in the bubble chamber were analyzed. Production of Δ^{++} (1238), Δ^- (1238) and ω^0 resonances was observed. The distribution of Δ^{++} and ω^0 as a function of four momentum transfer was similar to that of background. Center of mass angular distributions of the nucleons and pions were examined. The nucleons were peaked backward and the pions were essentially isotropic with a slight forward peaking in the π^+ case. (auth)

31530 EVIDENCE FOR THE $K^*(1300)$ IN π^-p INTERACTIONS AT 6 GeV/c. Crennell, David J.; Kalbfleisch, George R.; Lai, Kwan Wu; Scarr, J. Michael; Schumann, Thomas G. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. Phys. Rev. Lett., 19: 44-7(July 3, 1967). (BNL-11429).

Independent evidence from the interaction $\pi^- + p \rightarrow \Lambda + K^* \rightarrow \Lambda + K + \pi + \pi$ supporting the resonance interpretation for this $K^*(1300)^0$ is reported. A mass of 1300 MeV, a width of ~60 MeV and isospin ½ are found. These events were obtained from a systematic investigation of π^+p interactions at 6 GeV/c in a hydrogen bubble chamber. There were 1338 events found of the type studied. The mass spectra are shown. (J.F.P.)

31531 A STUDY OF THE REACTION $K^-p \rightarrow Y_1^*(1385) + \pi$ BETWEEN 780 and 1220 MeV/c. Armenteros, R. (CERN, Geneva); Ferro-Luzzi, M.; Leith, D. W. G.; (and others). Z. Phys., 202: 486-91(1967).

Measurements are reported of the total and differential cross sections for $Y^{*\pm}$ production in $K^- + p \rightarrow Y^{*+}(1385) + \pi^-$ and $K^- + p \rightarrow Y^{*-}(1385) + \pi^+$ interactions at 0.78 to 1.22 GeV/c. The influence of resonance formation on these channels is studied. The two resonances, $Y_1^*(1760)$ and $Y_0^*(1820)$, are formed in this momentum region and decay into $Y_1^*(1385) + \pi$. The branching fraction into $Y_1^*(1385) + \pi$ is measured and the quantum numbers are confirmed. (L.B.S.)

31532 LEPTONIC DECAY BRANCHING RATIO OF THE ρ MESON. Hyams, B. D. (CERN, Geneva); Koch, W.; Pellett, D.; Potter, D.; Von Lindern, L.; Lorenz, E.; Luetjens, G.; Stierlin, U.; Weilhammer, P. Phys. Lett., 24B: 634-7(June 12, 1967).

Preliminary results obtained from observing the reactions $\pi^- + LiH \rightarrow \mu^+ + \mu^- + \ldots\ \pi^- + LiH \rightarrow \pi^+ + \pi^- + \ldots$ using 11.2 GeV/c incident π^- mesons from the proton synchroton are reported. From these reactions the branching ratio $\Gamma(\rho \rightarrow \mu\mu)\ \Gamma(e \rightarrow \pi\pi)$ was determined. (auth)

31533 EXPERIMENTAL $K^*(1410)$ BRANCHING RATIOS. Field, J.; Hendricks, T.; Piccioni, O.; Yager, P. (Revelle Coll., La Jolla, Calif.). Phys. Lett., 24B: 638-41(June 12, 1967).

Four-prong reactions produced by K^-p collisions at 3.8 GeV/c were studied to determine the relative decay rates of the $K^*(1410)$. The branching ratios $K^*(892)\pi : K\rho : K\omega : K\eta$ are found to be $1 : <0.40$ (none observed) $: 0.10 \pm 0.04 : 0.07 \pm 0.04$ respectively. (auth)

31534 REACTION $K^- + p \rightarrow K^- + p + \pi^- + \pi^+$ AT 4.6 AND 5.0 GeV/c; EVALUATION OF $K^-\pi^-$ SCATTERING CROSS SECTION. Urvater, E. (Univ. of Colorado, Boulder); Kopelman, J. B.; Libby, L. Marshall; Campbell, W. B.; Juhalla, R. E.; Rhode, J. I. Phys. Rev. Lett., 18: 1156-9(June 19, 1967).

The reaction $K^- + p \rightarrow K^- + p + \pi^- + \pi^+$ near 5.0 BeV/c was examined. In events of the type $K^- + p \rightarrow K^{*0}(890) + p + \pi^-$ one-pion exchange appears to explain the interaction. Analysis of the scattering angular distribution at the π^-p vertex indicates that the p and π^- are produced as if scattering of the virtual exchanged pion pion is real. Similar analysis of events of the type $K^- + p \rightarrow N^{*++}(1236) + K^- + \pi^-$, with the assumption of real scattering between the K^- and π^-, yields information on the elastic differential, total elastic and total cross sections of $K^-\pi^-$ scattering. (auth)

31535 INVESTIGATION OF REACTIONS $\pi^- + p \rightarrow \pi^+ + \pi^- + m\pi^0 + n$ AND $\pi^- + p \rightarrow 2\pi^+ + 2\pi^- + m\pi^0 + n$ AT π^--MESON MOMENTUM 4 GeV/c. Bem, Ya.; Grishin, V. G.; Kistenev, E. P.; Lopylova, D. K.; Kriventsova, A. G.; Muminov, M. M.; Mu, Tsun; Ryabtsov, V. D.; Trika, Z. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 1054-9(May 1967). (In Russian).

The reactions $\pi^- + p \rightarrow n + \pi^+ + \pi^- + m\pi^0$ (1), and $\pi^- + p \rightarrow n + 2\pi^+ + 2\pi^- + m\pi^0$ (2) were studied by means of the propane bubble chamber at pc = 4 GeV. The events (1) were selected in which one and two π^0-mesons were produced: $(\sigma(\pi^0) = 3.8 \pm 0.7$ mb; $\sigma(2\pi^0) = 3.6 \pm 0.3$ mb). The reaction (1) with m = 2 was investigated in detail. The momentum and angular characteristics of π-mesons are obtained in c.m. system. The ω, ρ and η mesons production cross sections are small: ($\sigma \leq 0.2$ mb). Intensive nucleon isobar production of N* (1688) and N* (2190) in the reaction (1) is found. The reaction (2) is shown to proceed mainly via one−π^0-meson production. (auth)

31536 DETERMINATION OF THE ππ CROSS SECTION FROM THE REACTION OF PION PRODUCTION IN PION COLLISIONS WITH HYDROGEN AT SMALL MOMENTUM TRANSFER. Aref'ev, A. V.; Bayukov, Yu. D.; Zaitsev, Yu. M.; Kozodaev, M. S.; Leksii, G. A.; Osipenkov, V. T.; Suchkov, D. A.; Telenkov, V. V.; Fedorov, V. B. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 5: 1060-71(May 1967). (In Russian).

The $d^2\sigma/dp^2d\omega^2$ of the reaction $\pi^- + p \rightarrow \pi^+ + \pi^- + n$ is measured at initial pion energy 290 MeV in the region $4.1 < \omega^2 < 4.8$ and $0.5 < p^2 < 1.5$. The experimental data can be fitted by the one-meson-exchange approximation. The values of the elastic scattering cross sections obtained with the help of Chew−Low formula and using the linear extrapolation are 20.3 ± 2.3 mb and 30 ± 20 mb respectively. (auth)

31537 MEASUREMENT OF THE PROBABILITY RATIO FOR $\pi^-d \rightarrow nn$ AND $\pi^-d \rightarrow nn\gamma$ REACTIONS. Musin, M. A.; Petrukhin, V. I.; Prokoshkin, Yu. D. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 1072-8(May 1967). (In Russian).

The branching ratio $S = W(\pi^-d \rightarrow nn)/W(\pi^-d \rightarrow nn\gamma)$ for the π^--mesons stopped in deuterium is determined by relative method comparing the γ-quanta yield from the hydrogen and deuterium gas targets. The obtained value $S = 2.94 \pm 0.15$ disagree with that (1.6 ± 0.4), calculated from the data for π-meson production in nucleon−nucleon and γ-nucleon collisions. (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstract 31524.

31538 (ARL-67-0051) EXPONENTIAL MASS SPECTRUM OF ELEMENTARY PARTICLES. Callan, Edwin J. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Mar. 1967. 17p. CFSTI.

Elementary particles are considered to have quantized intrinsic masses which can be described systematically as exponential multiples of the electron mass in terms of two quantum numbers M_e and n, according to the general formula $m = m_e \exp \frac{1}{3}[A(M) - B(M)/n]$. Accuracy is to within 1.6% for leptons and mesons, and to within 2.5% for baryons. Some mesons like the η meson appear as mass harmonics of a basic heavier meson. The vector mesons and baryon decuplet are found as excited mass states of the pseudoscalar mesons and baryon octet, with the same quantum numbers M and n. Mass relations are obtained which closely approximate the Gell-Mann-Okubo relations for baryons, and are accurate to within 2.2 percent for the mesons. The mass relations also hold for the "excited" mass states. (auth)

31539 (ITF-67-6) ON SUMMATION OF THE CONTRIBUTIONS FROM THE FEYNMAN DIAGRAMS, AN EXISTENCE THEOREM. II. Petrina, D. Ya. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 28p. Dep.

It is shown that a solution to a previously considered equation $F = g\tilde{A}F + F^0$ [Petrina, D. Ya., preprint ITF-67-3,K., Naukova Dumka, 1967] for which a solution represented by an iteration series converging in the norm of space H was shown for sufficiently small $|g| < g_0$, exists for arbitrary complex g of the complex g-plane with the cut $|\mathrm{Re} g| \geq g_0$, $\mathrm{Im} g = 0$. This result is obtained by making use of the self-adjoint character of the linear operator $\tilde{A}$. (J.F.P.)

31540 (JINR-P2-3323) OB INTEGRAL'NYKH PREOBRAZOVANIYAKH, SVYAZANNYKH S URAVNENIEM KLEINA-GORDONA. (On Integral Transformation Connected With the Klein-Gordon Equation). Smorodinskii, Ya. A.; Surkov, E. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 11p. (In Russian). Dep.

Integral transformations are obtained which transform the functions on the cone $k^2 = 0$ into the solutions of the Klein-Gordon equation $(\partial^2 - m^2)\phi(x) = 0$ and inversely. The wave functions $\phi(x)$ are expanded into irreducible components under the Lorentz group in different frame of references. Integral transformations connecting the hyperboloid $p^2 = 1$ with the solutions of the d'Alembert equations are presented. (auth)

31541 (JINR-P2-3333) LEKTSII PO RELYATIVISTSKOI KINEMATIKE ODNOCHASTICHNYKH SOSTOYANII. (Lectures on Relativistic Kinematics of One-Particle States). Shelest, V. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 31p. (In Russian). Dep.

An apparatus of transformation of one-particle states under the operation of the Lorentz rotations, as well as of space ones, is considered. This apparatus is applied to perform the transformations from the physically important $P_z \to \infty$ frame of reference to the Breit frame. (auth)

31542 EMPIRICAL DISTRIBUTIONS IN MULTIPLE PRODUCTION AND THE UNCORRELATED JET MODEL. Bertocchi, L.; Zalewski, K. (CERN, Geneva). Nuovo Cim. (10), 49A: 577-92(June 21, 1967).

A method of calculating two- and more-particle distributions from the experimental one-particle distributions is presented. The method is based on the uncorrelated jet model. It takes into account energy-momentum conservation, but no other correlations are included. The method is applied to find the distribution of azimuthal angles between pairs of transverse momenta. The result is similar to the results obtained from a Monte Carlo calculation based on the statistical model. (auth)

31543 AUTOCOMPOSITE PARTICLES. Jouvet, B. (College de France, Paris); Le Guillou, J. C. Nuovo Cim. (10), 49A: 677-704(June 21, 1967). (In French).

The peculiar properties of particles composed of themselves (autocomposite particles) as compared to those composed of particles different from themselves (allocomposite particles) are studied. First using perturbation theory and the functional integration method to eliminate from the Lagrangian the autocomposite field a dangerous double limiting process which leads to nonlinear Lagrangians which are either local or nonlocal is stressed. The S-matrix equation for the autocomposite-particle propagator possesses similarly a singular solution (a contact nonpropagative propagator), and, as is shown in a detailed example, a physically sound propagator, which is found to contain an infinite sequence of resonances at exponentially increasing distances. It is noted that autocomposite fields and propagators of arbitrary spin (entire and half-entire) may satisfy the same equations in which a single fundamental constant occurs, the masses of the composite states of any spin being thereby related. Finally the meaning of the compositeness field relation on the field operators is briefly discussed. (auth)

31544 THEORY OF REGGEIZED BOOTSTRAPS. III. Abbe, W. J. (Univ. of Georgia, Athens); Nath, P.; Srivastava, Y. N. Nuovo Cim. (10), 49A: 716-30(June 21, 1967).

A theory for bootstrapping entire Regge eigentrajectories of a coupled-channel system is discussed. This is an extension of a recently proposed theory for bootstrapping Regge trajectories in the framework of single-channel processes. The formalism is based on a Regge representation for a partial-wave eigenamplitude which satisfies the following properties regardless of the number of eigentrajectories included; it has the correct threshold behavior for the real and the imaginary parts and it is unitary. The total scattering amplitudes are constructed in terms of eigentrajectories which have the correct Mandelstam-cut structure in the s-t-u plane and are also unitary. The representations are expected to converge rapidly in terms of the number of trajectories since the amplitudes used have been modified to take account of the infinite set of J-singularities in their Born limit. The relationship of Levinson's theorem to the motion of Regge eigenpoles is discussed. Invoking crossing, a set of bootstrap equations is obtained for a self-consistent determination of the Regge trajectories which occur as the sole input in the formalism. (auth)

31545 OUTLINE OF ALTERNATIVE APPROACHES TO PARTICLE SOLUTIONS OBEYING EINSTEIN'S GRAVITATION THEORY. Efinger, H. J. (Univ. of Georgia, Athens). Nuovo Cim. (10), 49A: 622-41(June 21, 1967).

Two general approaches to a classical theory of charged particles are presented to emphasize the meaning of gravitation as geometry in a classical theory of charged systems. One approach is due to Wheeler's attempt to construct charge and mass without introducing sources anywhere. This so-called geometrodynamical aspect leads to a departure from Euclidean topology. The other approach, following Euclidean topology in a Riemannian space-time, constructs particle models having sources of charge and mass. Point particles of Born-Infeld type and particles with finite size are discussed. The influence of an empty space of constant curvature on charge and mass of an embedded charged particle is investigated. The aim is twofold; namely first to show that the Einstein-Maxwell theory admits various solutions describing classical charged particles and second to stress Einstein's point of view of identifying gravitation with geometry in contrast to the usual field theory (flat space-time approach), which is concerned with approximations. Particle models can be constructed only from the full nonlinearity of the theory. To this end the common statement that gravitation behaves like a weakly interacting field is found to be unsubstantiated. (auth)

31546 RELATIVISTIC HYPERSPHERICAL FUNCTIONS OF THREE PARTICLES. Bogoslovskii, G. Yu.; Klepikov, N. P. (Moscow State Univ.). Yadern. Fiz., 5: 1126-33(May 1967). (In Russian).

The explicit expression of relativistic hyperspherical functions of five variables is presented describing three-particle states of free relativistic particles of an arbitrary spin. These functions are applied to the expansion of the amplitudes of three-particle reactions. (auth)

31547 ATTI DEL CONVEGNO SULLA FILOSOFIA NATURALE, OGGI, PISA, 17-21, SETTEMBRE 1964. (Pisa Symposium on Natural Philosophy, Pisa, Italy, September 17-21, 1964). Bernardini, G. (ed.). Nuovo Cim. (1), Suppl., 4: 305-527(1966). (CONF-640915).

Seven papers are included in the conference. Separate abstracts are prepared for 5 of the 7 papers. One paper was previously abstracted in NSA as 19: 37673. One paper on the role of scientific culture in modern society was not abstracted for NSA. (C.E.S.)

For abstracts of individual papers see: 31548, 31549, 31620, 31626, and 31637.

31548 EXTENSION OF MEASUREMENT. Wick, G. C. (Brookhaven National Lab., Upton, N. Y.). Nuovo Cim. (1), Suppl., 4: 309-45(1966).

From Pisa Symposium on Natural Philosophy, Pisa, Italy, Sept. 17-21, 1964. See CONF-640915.

The extension of measurement for the determination of various quantities in high energy physics is discussed. This discussion includes time, resolving power of instruments, the phase of scattered waves from a scattering experiment, and the Von Neumann theory of measurement. (J.F.P.)

31549 CONNECTION BETWEEN PHYSICS AND OTHER BRANCHES OF SCIENCE. Weisskopf, V. F. (CERN, Geneva). Nuovo Cim. (1), Suppl., 4: 465-91(1966).

From Pisa Symposium on Natural Philosophy, Pisa, Italy, Sept. 17-21, 1964. See CONF-640915.

The development of high energy physics is discussed, and the relation of high energy physics to other branches of science is described. (J.F.P.)

31550 PROCEEDINGS OF THE XIIIth INTERNATIONAL CONFERENCE ON HIGH-ENERGY PHYSICS, HELD AT BERKELEY, CALIFORNIA, AUGUST 31–SEPTEMBER 7, 1966. Berkeley and Los Angeles, Calif., University of California Press, 1967. 342p. $12.50. (CONF-660808).

The conference, which consisted of general discussion sessions later summarized for the proceedings, included 14 papers. Separate abstracts were prepared for each paper. (J.F.P.)

For abstracts of individual papers see: 31551, 31552, 31561, 31569, 31577–31579, 31596, 31597, 31622, 31623, 31628, 31629, and 31634.

31551 CURRENT TOPICS IN PARTICLE PHYSICS. Gell-Mann, Murray (California Inst. of Tech., Pasadena). pp 3-9 of Proceedings of the XIIIth International Conference on High-Energy Physics Held at Berkeley, California, August 31–September 7, 1966. Berkeley and Los Angeles, Calif., University of California Press, 1967.

See CONF-660808.

The summary of topics in particle physics includes field theory, Regge poles, scattering, masses and quantum numbers of hadron states, and the quark model. Also discussed are current algebra, invariance principles, and the structure of the weak interaction. (J.F.P.)

31552 CURRENT COMMUTATORS. Dashen, Roger (California Inst. of Tech., Pasadena). pp 51-60 of Proceedings of the XIIIth International Conference on High-Energy Physics Held at Berkeley, California, August 31–September 7, 1966. Berkeley and Los Angeles, Calif., University of California Press, 1967.

See CONF-660808.

The present status of the study of current commutators is summarized. This summary includes the commutation relations satisfied by current components, low-energy theorems for processes involving soft mesons (π), dispersion-theoretic sum rules, and saturation of sum rules and the connection between current algebras and symmetries. (J.F.P.)

Electromagnetic

Refer also to abstract 31591.

31553 (DESY–67/13) VECTOR MESONS AND THE ELECTROMAGNETIC INTERACTIONS OF HADRONS. Joos, H. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). May 1967. 23p. Dep.

In order to discuss the question of how results from experiments on the interaction of photons and electrons with nucleons has improved the understanding of the electromagnetic interaction of hadrons, several experimental results are considered under the uniform aspect of the vector dominance model. Some theoretical ideas on the meaning of the relation between the electromagnetic current of the hadrons and the phenomenological field of the vector mesons (ρ^0), (ω), and (ϕ), and the application of this model to the problems of the electromagnetic form factors, leptonic and radiative decays of mesons, photoproduction of mesons, etc., are given. A general view of the hadron electromagnetic interactions is given. (J.F.P.)

31554 (JINR-E2-3339) GENERALIZATION OF THE CABIBBO–RADICATI RELATION TO THE CASE OF NONMINIMAL ELECTROMAGNETIC INTERACTIONS. Baluni, V. Z. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 9p. Dep.

The modified Cabibbo-Radicati relation is derived taking into account possible nonminimality of the electromagnetic interactions. It is assumed only that the invariant amplitude vanishes at high energies. (auth)

31555 (NP–16795) NUCLEI AS ELEMENTARY PARTICLES. Primakoff, Henry (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). [1966]. 43p. Dep.

Previous work in which the weak interactions of nuclei are treated without any explicit consideration whatever of the nuclei as composed of nucleons is summarized. The weak interaction matrix elements between the initial and final nuclear states involved are described in terms of form factors characteristic of the nuclei as wholes. The numerical values of these form factors (at the relevant momentum transfers) reflect the complexity of the internal nuclear structure. Such a treatment is analogous to the customary treatment of weak and electromagnetic interactions of nucleons where nucleons are composed of quarks. Nuclear beta decay, nuclear muon capture, and sum rules in nuclear beta decay are covered. (J.F.P.)

31556 PHOTOPRODUCTION OF N*(1236) BY POLARIZED γ-QUANTA. Boeckmann, K.; Sandhas, W.; Wessel, H. (Univ., Bonn. KFA, Juelich, Ger.). Z. Phys., 202: 477-85(1967).

The one-pion-exchange model with gauge invariant extension is used to calculate cross sections and decay distributions for the reaction $\gamma p \rightarrow N^{*++} \pi^-$ where the γ-quanta are linearly polarized. It is shown that measurements with polarized γ-quanta would provide a sensitive check of the model. In particular, the relevance of the terms added to the one-pion-exchange part to guarantee gauge invariance could be tested. (auth)

31557 EVALUATION OF MULTIPOLES FOR PHOTO- AND ELECTROPRODUCTION OF PIONS. I. THEORETICAL BACKGROUND. Schwela, D.; Rollnik, H.; Weizel, R.; Korth, W. (Univ., Bonn). Z. Phys., 202: 452-76(1967).

A systematic study is made of the multipole amplitudes for electro- and photoproduction of pions in the low energy region. It is based on the integral equations following from fixed t dispersion relations and the Watson theorem. A discussion is first given of general mathematical problems one encounters when solving the singular integral equations. Especially the non-uniqueness of their solutions poses difficult problems which cannot be solved within the framework of the dispersion theory. As boundary conditions "from outside" the predictions of the static theory are used at threshold, but thereby only the magnetic dipole excitation of the first isobar is determined. For the electric quadrupole amplitude one needs additional conditions. (auth)

31558 THE REACTION $\gamma + {}^4He \rightarrow {}^3H + n + \pi^+$ IN IMPULSE APPROXIMATION. Kokott, T. P.; Locher, M. P.; Rollnik, H. (Univ., Bonn). Z. Phys., 202: 436-51(1967).

The reaction $\gamma + {}^4He \rightarrow {}^3H + n + \pi^+$ is calculated in the impulse approximation. The influence of nuclear wave functions on the differential cross section is discussed numerically using Gaussian and Irving–Gunn wave functions for the triton and the α-particle. The differences are large enough to be looked for experimentally. (auth)

31559 ON A 4-COMPONENT SPIN EQUATION OF NEUTRINO IN THE PRESENCE OF GRAVITATION IN THE CASE OF A NONLOCAL SPIN CONNECTION. Toro, T. Stud. Cercet. Mat., 17: 939-45(1965). (In Romanian).

The 4-component equation of neutrino is considered within the generalized theory of relativity. By using the notion of nonlocal and partially local spin affine connection, the equation of neutrino in a gravitational field is written for nonlocal spin connections. The resulting equations are integro-differential equations. (Romanian Science Abstracts)

31560 SYMMETRY OPERATORS OF COULOMB INTERACTION FOR THE CONFIGURATIONS $(d + s)^N$. Feneuille, S. (CNRS, Bellevue, France. Faculte des Sciences, Paris). J. Phys. (Paris), 28: 315-27(Mar.-Apr. 1967). (In French).

The Coulomb interaction within the configurations $(d + s)^N$ can be replaced by seven operators e_i, with well-defined transformation properties under the operations of the groups R_5 and R_6. The Clebsch–Gordan coefficients involved in the construction of these are calculated by a projection method using essentially the properties of Casimir's operators. The properties of the operators e_i with respect to symplectic symmetry (Sp_{12}) and quasi-spin are examined and by using the Wigner–Eckart theorem, the problem of the N-dependence of their matrix elements can be solved. Numerous factorizations allow calculations of these matrix elements from a small number of coefficients, which are tabulated. (auth)

31561 ELECTRODYNAMIC INTERACTIONS. Drell, S. D. (Stanford Linear Accelerator Center, Calif.). pp 85-99 of Proceedings of the XIIIth International Conference on High-Energy Physics Held at Berkeley, California, August 31–September 7, 1966. Berkeley and Los Angeles, Calif., University of California Press, 1967.

See CONF-660808.

Major experimental progress is reported for the electromagnetic form factors of the proton at large space-like and time-like values of the square of the invariant momentum transfer, the photoproduction of electron–positron and meson (μ) pairs as high-momentum tests of quantum electrodynamics, and the meson (μ) g – 2 value. These results have significant theoretical implications for an understanding of the hadron form factors and for increasing or delineating the domain of validity of QED. These implications are also discussed. (J.F.P.)

31562 SUPERCONVERGENT SUM RULE FOR PION PHOTOPRODUCTION ON LAMBDA^0. Srivastava, P. P. (IAEA, Trieste, Italy). Nuovo Cim. (10), 49A: 741-2(June 21, 1967). (IC–67/19).

From the study of a superconvergent sum rule in the photoproduction of mesons (π) on hyperons (Λ) it is found that this sum rule is very well satisfied within the framework of SU(3) and predicts for the transition magnetic moment of $\Sigma^+ \Lambda^0 \gamma$ the value $-\frac{2}{3}\sqrt{2}\mu_p$ (1.15), where μ_p is the total proton magnetic moment. (J.F.P.)

31563 η DECAY AND CURRENT ALGEBRA. Bardeen, W. A. (State Univ. of New York, Stony Brook); Brown, Lowell S.; Lee, B. W.; Nieh, H. T. Phys. Rev. Lett., 18: 1170-4(June 19, 1967).

It is shown that when the PCAC hypothesis and current algebra are systematically and carefully applied one finds within the framework of conventional electrodynamics that the decays $\eta \rightarrow 3\pi$ are allowed, the slope of the Dalitz plot for $\eta \rightarrow \pi^+ + \pi^- + \pi^0$ is -0.49, in excellent agreement with experiment, and the rate for $\eta \rightarrow 3\pi^0$ is at most of the order of 10^2 eV. (J.F.P.)

31564 SUM RULE FOR HIGH-ENERGY ELECTRON–PROTON SCATTERING. Gottfried, Kurt (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett., 18: 1174-7(June 19, 1967).

It is shown that the nonrelativistic quark model leads to an exceptionally simple sum rule involving a form factor determined by high-energy inelastic electron-proton scattering. The simplicity of this result appears to be a unique consequence of the peculiar quark changes. (auth)

31565 INVARIANT THEORY OF INTERACTION WITHOUT POTENTIALS. Tevikyan, R. V. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 2: 3-13(1967). (In Russian).

Without using potentials, a system of scalar particles interacting by the Yang-Mills field is investigated assuming that each particle has electric and magnetic charges. Quantum electrodynamics with magnetic monopole is constructed, and the electromagnetic interaction of the charged vector bosons is investigated. (auth)

31566 ANALYSIS OF RADIATIVE DECAYS AND GEOMETRICAL CHARACTERISTICS OF THE $X^0 \rightarrow Y^0 + \gamma \rightarrow 3\gamma$ DECAY. Guter, R. S.; Krestnikov, Yu. S.; Muratova, T. A. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 5: 1028-36(May 1967). (In Russian). (ITEF-456).

For three quanta decay the angles between γ-quanta pairs are arranged by the order of magnitude. The intermediate angle in the isotropic decay may characterize the mass of decaying particles. This characteristic weakly depends on the decay mode. The minimal angle distribution allows a conclusion to be made on the decay scheme. Analogous method can be applied to the analysis of the events involving particles with the velocities close to c. It is shown that the preliminary arrangement of the parameter under investigation and the analysis of several distributions instead of the one mixed make the selection of bound states much easier. (auth)

Weak

31567 (CTS-HE-67-3) HARMONIC ANALYSIS ON THE DALITZ PLOT (SPIN 0 CASE) WITH APPLICATIONS TO $K^\pm \rightarrow 3\pi$ DECAYS. Lee, B. W. (Miami Univ., Coral Gables, Fla. Center for Theoretical Studies). Mar. 1967. 32p.

Expansion of 3 pion wave functions and 3 pion decay amplitudes in terms of a complete set of orthonormal functions on the Dalitz plot is discussed. A new coordinate system (α,β) is proposed which is more convenient than the polar coordinates (ρ,θ) for this purpose. The desired harmonics $\lambda^n_m(\alpha,\beta)$ are then characterized as products of a polynomial in α, and a trigonometric function of β. It is noted that I, I_z and (m,n) completely characterize the $J = 0,3\pi$ system. The representation of the S-matrix in this orthogonal basis is considered, and the low Q-value behavior of the S-matrix elements and decay amplitudes in this representation is discussed. The method is then applied to phenomenological analysis of $K^\pm \rightarrow 3\pi$ decays. Deviations from the strict $\Delta I = \frac{1}{2}$ rule are carefully studied. It is noted that the presently available data indicate deviations from the $\Delta I = \frac{1}{2}$ rule in $K^\pm \rightarrow 3\pi$ decays on the basis of present knowledge on CP violating effects in $K_L \rightarrow 2\pi$ decays. (auth)

31568 NON-HERMITIAN WEAK HADRONIC CURRENT AND THE $\Sigma \rightarrow \Lambda$ LEPTONIC DECAY. Hertel, P. (Univ., Heidelberg). Z. Phys., 202: 383-96(1967).

It is shown that an antihermitian contribution to the isotriplet of weak hadronic strangeness-conserving currents leads to a change asymmetry. The existence of such currents with "wrong" G-parity is neither established nor refuted by existing experimental data. A deviation of $\Gamma(\Sigma^- \rightarrow \Lambda e^- \nu)/\Gamma(\Sigma^+ \rightarrow \Lambda e^+ \nu)$ from the phase space ratio by more than ≈ 2 percent strongly suggests the presence of an antihermitian weak hadronic current, irrespective of time reversal invariance or CVC being valid or not. (auth)

31569 WEAK INTERACTIONS. Cabibbo, Nicola (CERN, Geneva). pp 29-48 of Proceedings of the XIIIth International Conference on High-Energy Physics Held at Berkeley, California, August 31–September 7, 1966. Berkeley and Los Angeles, Calif., University of California Press, 1967.

See CONF-660808.

The summary of weak interaction theory includes leptonic, semileptonic, and nonleptonic interactions, universality of vector currents, Fermi beta and K_{e3} decays, and the experimental situation in K_{l3} decays. The fit to hyperon decays, universality of axial currents, PCAC and the Adler–Weisberger relations, the zero-energy theorem, the $K \rightarrow (n\pi)$ + lepton chain, nonleptonic K decays, and nonleptonic hyperon decays are also covered. (J.F.P.)

31570 K_{l5} FORM FACTORS FROM PCAC AND CURRENT ALGEBRA. McNamee, P. (Stanford Univ., Calif.); Oakes, R. J. Contract AF49(638)-1389. Phys. Lett., 24B: 629-33(June 12, 1967).

The K_{l5} form factors are calculated from current commutation relations and the partially conserved axial vector current hypothesis. (auth)

31571 TWO-BODY DECAY OF THE NEUTRON. Kabir, P. K. (Rutherford High Energy Lab., Chilton, Eng.). Phys. Lett., 24B: 601-2(June 12, 1967).

Characteristics of the rare two-body decay mode $n \rightarrow H + \bar{\nu}$ are examined. For β-decay coupling constants $g_V = 10^{-5}/M_p^2$. and $g_A/g_V = 1.18$, the expected branching ratio is 4×10^{-6} and the asymmetry parameter for polarized neutron decay is $A = 0.99$. (auth)

31572 K_{l3} DECAY. Calpacas, A. J. (Univ. of Rochester, N. Y.). Nuovo Cim. (10), 49A: 540-54(June 21, 1967). (UR-875-156).

Various spectra and correlation functions pertaining to the decay of a kaon into a pion and a lepton pair l, ν are computed under the assumption that the form factors are either constants or linear superpositions of terms, each of which has a resonant-type momentum transfer dependence. (auth)

31573 NONCONSERVATION OF THE VECTOR CURRENT AND THE MINIMALITY OF THE ELECTROMAGNETIC INTERACTION. Terent'ev, M. V. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 5: 1079-87(May 1967). (In Russian).

Some consequences of the relation $\partial_\mu j_\mu^{(s)}(x) = \pm ieA_\mu(x) j_\mu(x)$ that express the minimality of the nonconservation of the charged vector current are considered. The relation is obtained between some combination of the β-decay form factors and the amplitude of the virtual Compton effect. A relation is also obtained between amplitudes of some weak processes accompanied by the γ-quanta emission. (auth)

31574 PION PRODUCTION AT THRESHOLD IN NEUTRINO INDUCED REACTIONS. Vainshtein, A. I.; Sokolov, V. V.; Khriplovich, I. B. (Novosibirsk State Univ., USSR). Yadern. Fiz., 5: 1088-91(May 1967). (In Russian).

Amplitude of the pion threshold production in neutrino induced reactions at the momentum transfer $|k^2| \lesssim \mu^2$ is found with the current algebra and with the hypothesis that the matrix element of the hadron weak current depends on the momenta smoothly. (auth)

Strong (General)

31575 SOME IMPLICATIONS OF THE QUARK MODEL FOR HIGH ENERGY SCATTERING. Lipkin, Harry J. (Weizmann Inst. of Science, Rehovoth, Israel). Z. Phys., 202: 414-24(1967).

The expressions for total scattering cross sections obtained from the quark model are expressed in a simple form which shows the dependence of the results on the assumptions. The results are shown to depend only on the value of six constants or "charges" defined for each hadron and to be otherwise independent of the structure. Any model which gives the same values of these charges gives the same result as the quark model. In particular, the results for processes which have odd signature t-channel quantum numbers hold in a quark model even with arbitrary mixtures of additional quark-antiquark pairs in the hadron wave function, provided that B, Y, and I are conserved. (auth)

31576 MASS DIFFERENCES AND VECTOR CURRENTS. Hefft, K.; Stech, B. (Univ., Heidelberg). Z. Phys., 202: 514-24 (1967).

Hadron mass differences are related to the divergences of the weak hadronic vector currents. The nearly conserved SU(3)-charges are used to understand the approximate validity of mass formulas. A simple argument is presented—involving the formal quark structure of the relevant operators—for octet dominance,

and equal d/f-ratios for the strong mass differences and the leading part of the electromagnetic mass splitting are predicted. Furthermore, mass formulas connecting different SU(3)-multiplets are derived. A remarkable universality property of the coupling of the various particles to the divergences is observed by which even baryon and meson mass differences are related. (auth)

31577 DYNAMICS OF STRONG INTERACTIONS. Low, Francis (Massachusetts Inst. of Tech., Cambridge). pp 241-9 of Proceedings of the XIIIth International Conference on High-Energy Physics Held at Berkeley, California, August 31–September 7, 1966. Berkeley and Los Angeles, Calif., University of California Press, 1967. (MIT-2098-272).

See CONF-660808.

A general discussion of the state of the field of strong interaction dynamics is given. Also the analytic structure of partial waves, off-mass shell dynamical questions, S-matrix dynamics, and bootstrap models are briefly discussed. (J.F.P.)

31578 HADRON COLLISIONS AT VERY HIGH ENERGIES. Van Hove, L. (CERN, Geneva). pp 253-78 of Proceedings of the XIIIth International Conference on High-Energy Physics Held at Berkeley, California, August 31–September 7, 1966. Berkeley and Los Angeles, Calif., University of California Press, 1967.

See CONF-660808.

A number of recent results and developments concerning hadron collisions are reviewed. The main concern is with the high-energy region above 4 or 5 GeV/c, although lower energy regions are mentioned occasionally. A systematic review of experimental results is also included. Two-body collisions at low momentum transfers, large-angle scattering, multiple production of particles, the quark model, and Regge pole theory are covered. (J.F.P.)

31579 PERIPHERAL COLLISIONS AT INTERMEDIATE ENERGIES. Jackson, J. D. (Univ. of Illinois, Urbana). pp 149-71 of Proceedings of the XIIIth International Conference on High-Energy Physics Held at Berkeley, California, August 31–September 7, 1966. Berkeley and Los Angeles, Calif., University of California Press, 1967.

See CONF-660808.

Hadron initiated processes at incident momenta between 1 and 10 GeV/c are considered. The inelastic processes in which the number or masses (or both) and often the spins of the outgoing particles are different from those of the incident particles are discussed. Results at momenta less than 1 GeV/c, which are mainly on single meson (π) and eta photoproduction, are mentioned briefly. (J.F.P.)

Strong (Baryon No. = 0)

Refer also to abstract 31594.

31580 (JINR-P2-3310) O NEKOTORYKH KORRELYATSIONNYKH SVOISTVAKH PAR $K^0\overline{K}^0$. (On Some Correlation Properties of $K^0\overline{K}^0$ Pairs). Lyuboshits, V. L.; Okonov, E. O.; Podgoretskii, M. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1967. 8p. (In Russian). Dep.

Correlations in strong decays of a $K^{0*}\overline{K}^{0*}$ pair into neutral particles were considered. It is shown that if CPT is not preserved, the $K^0\overline{K}^0$ pair can decay according to the $K_L K_S$ scheme at even orbital moments. (auth)

31581 GENERALIZED WEINBERG SUM RULES AND THE AXIAL-VECTOR CABIBBO ANGLE. Nieh, H. T. (State Univ. of New York, Stony Brook). Phys. Rev. Lett., 19: 43-4(July 3, 1967).

Previous arguments for the generalization of the Weinberg sum rules for the spectral functions of currents are applied to derive sum rules by considering the propagation functions for the axial-vector currents with the internal quantum numbers of π and K, respectively. Assuming the dominance of these sum rules by suitable low-lying states, an expression is found for the ratio F_K/F_π which in the Cabibbo theory for the semileptonic weak interactions measures the SU(3) breaking effect on the Cabibbo angle in the two-body leptonic decays of the pseudoscalar mesons. (J.F.P.)

31582 WEINBERG'S SUM RULE AND SPECTRA OF SPIN 1^+ MESONS. Acharya, R. (American Univ. of Beirut). Phys. Lett., 24B: 623-4(June 12, 1967).

The Weinberg sum rules which relate the spectra of the vector and axial-vector mesons are re-examined with special attention to the continuum contributions. An alternative explanation of the equality $m_A^2 = 2m_V^2$ is offered, based on the Johnson sum rule relating the bare and physical masses of a spin-1 particle. (auth)

31583 ELEMENTARY DERIVATION OF WEINBERG'S MASS RELATION. Sakurai, J. J. (Scuola Normale Superiore, Pisa, Italy). Phys. Lett., 24B: 619-20(June 12, 1967).

An elementary derivation of Weinberg's relation $m_{A_1} = \sqrt{2}m_\rho$ is presented. (auth)

31584 A STUDY OF THE QUARK REARRANGEMENT MODEL OF NUCLEON–ANTINUCLEON ANNIHILATION. Harte, J.; Socolow, R. H.; Vandermeulen, J. (CERN, Geneva). Nuovo Cim. (10), 49A: 555-76(June 21, 1967).

A model of proton-antiproton annihilation via quark rearrangement suggested by Rubinstein and Stern is examined in detail. This model predicts that all final states are three-meson states, made from the set $\pi, \eta, X, \rho, \omega$, and allows a computation of their relative rates. Its predictions are compared with experimental data at rest and at several energies in flight. The model is found not to be able to account for more than 25% of the annihilations at rest, even when maximum freedom is given to certain extra parameters. The model underestimates the importance of high-multiplicity states in annihilations in flight and also fails to predict the more detailed features of these data. A number of interesting aspects of the data are uncovered and possible directions along which the model might be modified are suggested. (auth)

31585 STRESS TENSOR AND THE 2^+ MESONS. Delbourgo, R. (Imperial Coll. of Science and Tech., London); Salam, A.; Strathdee, J. Nuovo Cim. (10), 49A: 593-605(June 21, 1967).

It is suggested that the recently discovered 2^+ particles have the stress tensor $\theta_{\mu\nu}$ and its octet generalizations $\theta^i_{\mu\nu}$ as their sources. Consequences of this hypothesis are examined. (auth)

31586 HIGHER PARTIAL WAVES IN LOW ENERGY $\pi\pi$ SCATTERING. Orlov, I. I.; Parfenov, Yu. V. (Inst. of Mathematics, Moscow). Yadern. Fiz., 5: 1102-9(May 1967). (In Russian).

Equations for the s, p, d and f waves in the low energy $\pi\pi$-scattering are obtained in the framework of the differential method. The spectral representation for the amplitude is obtained with $x = tu$ as a fixed parameter. Application of the conformal mapping is discussed. In case of charged particles the ρ-meson width may increase by 30 to 35 MeV with the f^0-meson taken into account. (auth)

31587 POSSIBLE NONADDITIVITY OF QUARK AMPLITUDES IN HIGH-ENERGY CROSS SECTIONS. Franco, Victor (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev. Lett., 18: 1159-62(June 19, 1967). (UCRL-17510).

The possible nonadditive character of quark amplitudes and the resulting additional contributions to total cross sections are investigated. A sum rule is derived and it is suggested that the nonadditive contributions to some cross sections may be dominant. (auth)

31588 SATURATION OF SUPERCONVERGENCE RELATIONS AND CURRENT-ALGEBRA SUM RULES FOR FORWARD AMPLITUDES. Gilman, Frederick J. (California Inst. of Tech., Pasadena); Harari, Haim. Contracts AT(11-1)-68; AT(04-3)-515. Phys. Rev. Lett., 18: 1150-3(June 19, 1967).

The algebra of charges and their time derivatives, partially conserved axial-vector currents, and Regge high-energy behavior are used to derive sum rules for strong-interaction forward amplitudes. The saturation of all sum rules by a finite number of states is self-consistent and leads to relations among coupling constants and masses. Saturating all sum rules for π-ρ scattering by π, ω, and A_1, $m_{A_1} = 1100$ MeV, $m_\omega = m_\rho$, $\Gamma_{A_1} = 120$ MeV, $g_{\omega\rho\pi} = 21$ BeV^{-1}, are predicted in good agreement with experiment. (auth)

31589 COMPLEX DOUBLE POLE AND DECAY LAW. Lukierski, J. (Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 15: 223-9(1967).

Operators of the first and second order poles with complex mass were introduced. An explicit law of the decay of unstable particles described by the first and second order poles was determined. A generalization for the unstable charged particles was found. (R.V.J.)

Strong (Baryon No. = 1)

Refer also to abstract 31700.

31590 (JINR-P2-3337) RAZREZY V KOMPLEKSNOI l-PLOSKOSTI I POVEDENIE SECHENII NEUPRUGIKH PROTSESSOV. (The Cut-Offs in the Complex l-Plane and the Behavior of Inelastic Process Cross Sections). Dao Wong Duc; Nguyen Van Hieu; Tavkhelidze, A. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 9p. (In Russian). Dep.

The role of cut-offs in the asymptotic behavior of the scattering amplitudes is considered. It is shown that the differential cross section behavior of a number of inelastic processes essentially depends on the presence of cut-offs. (auth)

31591 (NP-16821) KINEMATICAL CONSTRAINTS ON REGGE POLE RESIDUES. Diu, B.; Le Bellac, M. (Paris Univ.,

Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). Apr. 1967. 22p. (TH-198). Dep.

The problem of kinematical singularities and zeroes of Regge pole residues for processes with external spins is re-examined. The analyticity of the classical Mandelstam invariants introduce additional constraints into the Reggeization procedure proposed by L. L. Wang. The way these constraints work is described on simple examples, and the role of daughter trajectories is discussed; in particular, the latter are found to satisfy the factorization theorem. These considerations are then applied to vector meson production and charged pion photoproduction. In particular, the sharp forward peak observed in this last process, as in neutron-proton charge exchange, is seen to raise a serious problem within the Regge pole model. (auth)

31592 (UCRL-17502) PHYSICAL INTERPRETATION OF STATIC MODEL PARAMETERS. Markley, F. Landis (California Univ., Berkeley. Lawrence Radiation Lab.). Apr. 5, 1967. Contract W-7405-eng-48. 59p. Dep. CFSTI.

Thesis.

It is shown that an approximation to the static crossing matrix leads to a soluble model for the p_{11} and p_{33} πN scattering amplitudes in which the parameters are related to forces due to particle exchanges in the t-channel. Reasonable values of these forces give the nucleon bound state and the Δ resonance in good agreement with experiment. Properties of the model are further investigated. (auth)

31593 ANALYSIS OF THE $\pi^{\pm}$p POLARIZATION DATA AT HIGH ENERGIES. Hoehler, G.; Eisenbeiss, G. (Technische Hochschule, Karlsruhe, Ger.). Z. Phys., 202: 397-400(1967).

The results of a phenomenological analysis are compared with the Regge model. (auth)

31594 THE ADLER-WEISBERGER SUM RULE. Mueller, V. F. (Univ., Heidelberg. Kernforschungszentrum, Karlsruhe, Ger.); Rothleitner, J. Z. Phys., 202: 349-63(1967).

Starting from a weak form of the axial current algebra and using Fubini's covariant dispersion method a fairly rigorous derivation of the Adler-Weisberger sum rule is given. Special attention is given to the necessary continuation in the "pion mass." Combining the sum rule with the forward $\pi^{\pm}$p dispersion relation a sum rule is obtained containing essentially low energy data. A numerical evaluation is given for two sets of existing s-wave πN scattering lengths. The one reproduces Adler's and Weisberger's results; the other improves the agreement with experiment giving $r_A = 1.20$. (auth)

31595 SUM RULES IN PERTURBATION THEORY. Kramer, G. (Physikalisches Staatsinstitut, Hamburg); Meetz, K. Z. Phys., 202: 525-42(1967).

Sum rules derived from isospin current algebra are examined in perturbation theory for nucleons interacting with neutral pseudoscalar mesons and isovector pions. It is shown that the well-known sum rules for electromagnetic isovector form factors of nucleons and pions are correct in zero and second order of the meson-nucleon coupling constant. (auth)

31596 S = 0 BARYON RESONANCES. Murphy, P. G. (Manchester Univ., Eng.). pp 175-82 of Proceedings of the XIIIth International Conference on High-Energy Physics Held at Berkeley, California, August 31-September 7, 1966. Berkeley and Los Angeles, Calif., University of California Press, 1967.

See CONF-660808.

Results on the properties of resonance with B = 1 and S = 0 are summarized. The definition of a resonance, methods for studying resonances, elastic and inelastic scattering are covered. (J.F.P.)

31597 BARYON RESONANCES WITH S $\neq$ 0. Ferro-Luzzi, Massimiliano (CERN, Geneva). pp 183-211 of Proceedings of the XIIIth International Conference on High-Energy Physics Held at Berkeley, California, August 31-September 7, 1966. Berkeley and Los Angeles, Calif., University of California Press, 1967.

See CONF-660808.

The discussion of hyperon resonances includes the S = -1 resonances, presented in decreasing mass order, the S = -2 resonances, S = +1 enhancements found in a study of the K + N system and their possible interpretation as resonances, and a possible multiplet arrangement for the baryons. (J.F.P.)

31598 SUPERCONVERGENCE IN NUCLEON-ρ MESON SCATTERING. Korthals Altes, C. P. (IAEA, Trieste, Italy). Nuovo Cim. (10), 49A: 753-5(June 21, 1967).

Two sum rules for meson (ρ)-nucleon coupling constants and the coupling constant C_3^{ρ} related to the magnetic transition ρNN^*_{33} are derived on the basis of superconvergent dispersion relations. The process of ρ + N elastic scattering is considered. (J.F.P)

31599 EFFECT OF AN INELASTIC CHANNEL ON THE POSITION AND WIDTH OF A RESONANCE. II. DerSarkissian, M. (Temple Univ., Philadelphia). Nuovo Cim. (10), 49A: 743-6(June 21, 1967).

An investigation is made of the equation $\Gamma_{11} = [1 + (\Delta m)^2 L'(\tilde{s}_R)/\Gamma_{22}]\tilde{\Gamma}_{11}$, where $\Delta m = \tilde{s}_R - s_R$ is the (mass shift)^2 caused by turning on the perturbing channel, s_R is the (mass of the resonance)^2 in the inelastic approximation, $\tilde{s}_R$ is the same in the elastic approximation, Γ_{22} (>0 because of unitarity) is the reduced width of the resonance coupling to the 2 $\rightarrow$ 2 channel, $L'(\tilde{s}_R) \equiv (dL(s)/ds)_{s=\tilde{s}_R}$ and L(s) in the uncoupled phase parameter. The example used for this study is π + N scattering through the (3,3) resonance, the Δ_{33}. The inelastic channel KΣ is chosen. (J.F.P.)

31600 CONVERGENCE RELATIONS FROM REGGE BEHAVIOR. Gatto, R. (Univ., Florence. Istituto Nazionale di Fisica Nucleare, Florence). Nuovo Cim. (10), 49A: 747-9 (June 21, 1967).

A convergence relation for meson-baryon scattering, resulting from the assumption that the Regge trajectory for the exchange of a 27-plet in the t-channel has a negative intercept, is presented and its saturation discussed. (J.F.P.)

31601 DISPERSION RELATION PREDICTIONS FOR KN CHARGE EXCHANGE AND $K_L \rightarrow K_S$ REGENERATION. Lusignoli, M. (Univ., Rome); Restignoli, M.; Snow, G. A.; Violini, G. Nuovo Cim. (10), 49A: 705-15(June 21, 1967).

Forward dispersion relation predictions for the real parts of the ($K^{\pm}$,n) scattering amplitudes are presented. Using these results together with the ($K^{\pm}$,p) amplitudes previously evaluated, the forward charge exchange amplitudes for the reactions $K^-p \rightarrow K^0n$ are calculated and $K^+n \rightarrow K^0p$ and compare them with experiment. Also the $K_L^0 \rightarrow K_S^0$ regeneration phase is evaluated. (auth)

31602 FURTHER CONSEQUENCES OF THE QUARK MODEL IN INELASTIC MESON-BARYON SCATTERING. Friar, J. L. (Stanford Univ., Calif.); Trefil, J. S. Nuovo Cim. (10), 49A: 642-72(June 21, 1967).

A model of inelastic meson-baryon scattering in terms of quark scattering is presented. Relations are found between cross sections for various processes, and predictions are made for density matrix elements where particles of higher spin are produced. A number of predictions are made which do not depend on assumptions about quark dynamics other than those inherent in the quark scattering model. A comparison is made with experimental data. (auth)

31603 A THRESHOLD THEOREM DERIVED FROM CURRENT ALGEBRA $SU_2 \times SU_2$. Olesen, P. (Univ. of Copenhagen); Pietschmann, H. Nuovo Cim. (10), 49A: 673-6(June 21, 1967).

Using current algebra, PCAC and the assumption that the total cross sections for zero-mass pion scattering are explicitly independent of the pion mass, a threshold theorem for pion-nucleon scattering is shown which states that $a_1 + 2a_3 = 0$ (where a_1 and a_3 are the S-wave scattering lengths). (auth)

31604 ASYMPTOTIC PREDICTIONS OF FORWARD π-N DISPERSION RELATIONS. Gajdicar, T. J.; Moffat, J. W. (Univ. of Toronto). Phys. Rev. Lett., 18: 1154-5(June 19, 1967).

Recent Coulomb-interference measurements of α = Ref/Imf are analyzed in terms of forward π-N dispersion relations. The results are consistent with a crossover of $\sigma^{(-)} = \frac{1}{2}(\sigma_- - \sigma_+)$ at high energies above 22 BeV. The ρ-trajectory model determined by charge-exchange experiments is compared with the analysis of the data between 8 and 20 BeV. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstract 31701.

31605 (BNL-11479) EMPIRICAL FORMULAS FOR PARTICLE PRODUCTION IN P-Be COLLISION BETWEEN 10 AND 35 BeV/c. PART II. Sanford, J. R.; Wang, C. L. (Brookhaven National Lab., Upton, N. Y.). May 1, 1967. 32p. Dep. CFSTI.

Formulas of the same type as those previously presented for meson (π) multiplicities are given for meson (K) and antiproton production. The calculated momentum spectra for mesons (K^+), (K^-), and antiprotons are plotted and presented with the experimental data. Also the multiplicities, mean secondary and transverse momenta, and inelasticities are given. (auth)

31606 (INR-783/VII/PL) HYPERTRITON WITH SEPARABLE NONLOCAL INTERACTION WITH HARD SHELL REPULSION. Borysowicz, Jerzy; Dabrowski, Janusz (Institute of Nuclear Research, Warsaw (Poland)). 1967. 10p. Dep.

The $_{\Lambda}H^3$ problem is solved exactly with separable nonlocal nucleon-nucleon and Λ-nucleon potentials with a hard shell of radius $r_c = 0.4$ fm. For three sets of Λ-nucleon scattering parameters, the binding energy and the probability of the S' state are calculated. (auth)

31607 SOME REMARKS CONCERNING THE COMPOSITENESS CONDITIONS. Yoshimura, T. (Univ., Innsbruck). Nuovo Cim. (10), 49A: 750-2(June 21, 1967).

The theory of composite particles based on Lagrangian field theory is considered. It is believed that the condition $Z_1 = 0$ is independent of $Z_3 = 0$, but a dynamically generated pole is not always describable as a contribution of a particle with $Z_3 = 0$. The scalar deuteron consisting of scalar proton and scalar neutron with other interactions responsible for binding the deuteron is considered. (J.F.P.)

31608 A NOTE ON THE HIGH-ENERGY DEUTERON SCATTERING FROM FADDEEV'S THREE-PARTICLE FORMULATION. Bhasin, V. S. (IAEA, Trieste, Italy). Nuovo Cim. (10), 49A: 735-40(June 21, 1967).

The approximations involved in high energy scattering of deuterons using the impulse approximation are studied in a more general framework. An attempt is made to study this problem starting from the Faddeev three-particle multiple-scattering theory, and it is found how far the single and double scattering terms in this general approach can be reduced to the Glauber approximate form. (J.F.P.)

31609 DOUBLE-SCATTERING CONTRIBUTIONS TO THE PROTON–PROTON DIFFERENTIAL CROSS SECTION IN THE QUARK MODEL. Harrington, David R.; Pagnamenta, Antonio (Rutgers-The State Univ., New Brunswick, N. J.). Phys. Rev. Lett., 18: 1147-50(June 19, 1967).

It is pointed out that the double scattering effects in the quark model shown previously by Franco provides a natural explanation for the sharp break in the high-energy proton–proton differential cross section at a momentum transfer square of about 0.6 GeV/c^2. An attempt is made to make semiquantitative estimates of the double scattering contribution to the proton–proton differential cross section assuming a quark-model description of the protons. The elastic scattering of two high-energy protons in the cms system is considered. It is assumed that each proton is composed of three quarks and may be described by a nonrelativistic completely antisymmetric spatial wave function. (J.F.P.)

Particle Invariance Principles and Symmetries

General

31610 (AD–654316) UNITARY REPRESENTATIONS OF U(2,2) AND MASSLESS FIELDS. Kursunoglu, Behram (Miami Univ., Coral Gables, Fla. Center for Theoretical Studies). Dec. 1966. 23p. (CTS-HE-66-8). CFSTI.

A discussion is given of unitary irreducible representations of the U(2,2) group in terms of the noncompact algebra of creation and annihilation operators and of some applications to massless fields. In particular, the U(2,2) algebra yields discrete values for P_4 (energy), one of its generators. The little group and wave equations of massless fields are also derived from the Lie algebra of U(2,2). (auth)

31611 (JINR-E2-3294) UNITARY REPRESENTATIONS OF THE LORENTZ GROUP AND FUNCTIONS WITH SPIN. Liberman, M. A.; Smorodinskii, Ya. A.; Sheftel, M. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 26p. Dep.

Irreducible unitary representations of the Lorentz group are constructed, which are realized on the space of functions, defined on the direct product of the two spaces—a hyperboloid (with an infinite-dimensional representation) and a sphere (with a finite-dimensional spin representation). These functions form the basis for the integral representations of scattering amplitudes. They also form the complete set of functions in which an arbitrary solution of relativistic field equations expands for the fields with a fixed spin. (auth)

31612 (LPTHE-TH-183) ON THE REGGE SYMMETRIES OF THE 3J SYMBOLS OF SU(2). Flamand, G. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). [1966]. 17p. Dep.

The symmetries of the 3j symbols of SU(2) are fitted into a broader group theory framework. The 3j symbols of SU(2) are identified with certain 3j symbols of SU(3). Viewed as SU(3) properties, their Regge symmetries are nothing but ordinary permutation symmetries. (auth)

31613 BHABHA EQUATIONS AND IMAGINARY PARITY OF FERMIONS. Franz, Walter (Univ., Muenster, Ger.). Z. Phys., 202: 412-13(1967). (In German).

The Lie algebra of the Bhabha wave equation yields internal transformations of the fields not only for the special Lorentz group but also for the complete Lorentz group. For parity (as well as for all other reflection axes of R_4) only the eigenvalue $\pm i$ of the imaginary parity class results for fermions. (tr-auth)

31614 SPONTANEOUS SYMMETRY BREAKING AND CONSTANT GAUGE TRANSFORMATIONS. Nagy, K. L. (Roland Eoetvoes Univ., Budapest). Acta Phys. Acad. Sci. Hung., 23: 17-27(1967).

Symmetry breaking solutions of several model theories are investigated with the result that constant gauge transformations of the fields describing zero-mass Goldstone particles are responsible for the formal possibility of the spontaneous symmetry breaking. (auth)

31615 ALGEBRAIC METHODS IN THE THEORY OF SPECIAL UNITARY GROUPS. II. QUASISPIN AND MULTIPLET STRUCTURE. Sebestyen, A.; Nyiri, J. . (Central Research Inst. for Physics, Budapest). Acta Phys. Acad. Sci. Hung., 23: 37-51(1967).

A simple method revealing the multiplet structure of irreducible representations of SU(3) is discussed. (auth)

31616 ON REALIZATIONS OF LIE ALGEBRAS AND SYMMETRIES IN CLASSICAL AND QUANTUM MECHANICS. Rosen, J. (Brown Univ., Providence). Nuovo Cim. (10), 49A: 614-21 (June 21, 1967). (NYO-2262TA-138).

Realization of any Lie algebra having a faithful $n \times n$ matrix representation and dimension less than n^2 in terms of 2n canonical variables (in the classical case) or 2n creation and annihilation operators (in the quantum case) is performed. Sufficient conditions for the Hamiltonian to be invariant with respect to this algebra are presented. In addition, the Lie algebras of $SU_{a,b}$, $a + b = n + 1$, and $O_{c,d}$, $c + d = n + 2$, are realized by functions of 2n canonical variables. (auth)

31617 THE CONFORMAL GROUP AS A CANDIDATE FOR THE RELATIVISTIC EXTENSION OF ELEMENTARY PARTICLE SYMMETRIES. Halbwachs, F. (Faculte des Sciences, Marseille). Nuovo Cim. (10), 49A: 517-39(June 21, 1967).

An "embedding scheme" is proposed for the elementary-particle physics, in the frame of the conformal group $SO_{4,2} \approx SU_{2,2}$, which contains as subgroups (and is completely generated by) the de Sitter group $SO_{4,1}$—which is looked at as accounting for the dynamical features (as it admits the Poincaré group as a contraction limit)—and the group $SU_{2,1}$—which is a noncompact form of SU_3 and is able to classify the particles according to isospin and hypercharge. A mass splitting procedure is derived from this scheme, which introduces the "symmetry breaking" in accordance with an exact conformal invariance. (auth)

31618 FINITE TRANSFORMATIONS OF FINITE-DIMENSIONAL REPRESENTATIONS OF THE LORENTZ GROUP. Tkharev, E. E.; Fedorov, F. I. (Belorussian State Univ., Minsk). Yadern. Fiz., 5: 1112-15(May 1967). (In Russian).

General covariant expressions for a finite transformation of an arbitrary finite-dimensional representation of the Lorentz group are obtained as well as expressions for the representation corresponding to any finite-dimensional relativistic wave equation. The consideration is based on the complex vector parametrization. (auth)

31619 CLASSIFICATION OF SYSTEMS OF GENERALIZED WAVE FUNCTIONS REALIZING REPRESENTATIONS OF THE L(m,n) AND P(m,n) GROUPS. Sheftel, M. B. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 1116-25(May 1967). (In Russian).

A class of unitary irreducible representations of the L(m,n) and P(m,n) groups dependent on one parameter only and realizable in the eigenfunctions space of the multidimensional Laplacian for the space R, is considered. The rules are established for construction of the coordinate system in R space necessary for the classification of the basic functions after an arbitrary given chain of subgroups as well as the rules for construction of the system itself of the basic functions in these coordinates. The problem of the normalization of the basis with methods of the integral geometry is considered. (auth)

31620 SYMMETRIES IN FUNDAMENTAL INTERACTIONS. Gatto, R. (Univ., Florence). Nuovo Cim. (1), Suppl., 4: 414-64(1966).

From Pisa Symposium on Natural Philosophy, Pisa, Italy, Sept. 17–21, 1964. See CONF-640915.

A mathematical exposition of the properties of the SU(3) generators and representations is given. The physical interpretation of the theory is discussed, and its successful predictions are reviewed. Also the higher algebra $SU(3) \otimes SU(3)$ is considered. (J.F.P.)

Applications (Electromagnetic and Weak)

31621 SU(6) AND SUPERCONVERGENCE OF PION PHOTOPRODUCTION. Saito, Satoru (Univ. of Wisconsin, Madison). Phys. Rev. Lett., 19: 53-6(July 3, 1967).

The superconvergence sum rules of pion photoproduction amplitudes are studied to predict the electromagnetic properties of the nucleon and 3-3 nucleon resonance. Exactly the same results are obtained for the D/F ratio of nucleon magnetic moment and magnetic dipole decay width of the 3-3 resonance as from static SU(6). The problem of saturation of the intermediate-state summation by low-lying resonances is discussed. (auth)

31622 EXPERIMENTS IN T, C VIOLATION. Fitch, V. L. (Princeton Univ., N. J.). pp 63-71 of Proceedings of the XIIIth International Conference on High-Energy Physics Held at Berkeley, California, August 31–September 7, 1966. Berkeley and Los Angeles, Calif., University of California Press, 1967.

See CONF-660808.

New experimental results relevant to the questions of CP, T, and TCP invariance are reviewed. The main question is whether or not the CP noninvariance shown by K decay is limited to the weak interaction. A number of clashing experimental results concerning η decay were reported. These are summarized. (J.F.P.)

31623 OTHER ASPECTS OF WEAK INTERACTIONS: HIGH ENERGY NEUTRINO PHYSICS AND QUESTIONS OF C, P, T NONINVARIANCE. Lee, T. D. (Columbia Univ., New York). pp 75-81 of Proceedings of the XIIIth International Conference on High-Energy Physics Held at Berkeley, California, August 31–September 7, 1966. Berkeley and Los Angeles, Calif., University of California Press, 1967.

See CONF-660808.

The status of high energy neutrino physics is briefly summarized, and the phenomenological analysis of CP-nonconserving interactions is considered. The decays of the mesons (K^0) and (η) are discussed. In the experimental situation only the $K_2^0 \rightarrow \pi^+ + \pi^-$ shows CP nonconservation. In other reactions, such as η decay, the experimental facts for CP violation are confused. But there are many CP violating theories. (J.F.P.)

31624 PREDOMINANCE OF CP VIOLATION IN THE I = 2 2π STATE IN $K^0 \rightarrow 2\pi$ DECAY. Mathur, V. S. (Univ. of Rochester, N. Y.). Nuovo Cim. (10), 49A: 731-5(June 21, 1967). (UR-875-183).

It is shown that the CP violation in $K \rightarrow 2\pi$ decay, found from the measured rate for the $K_2^0 \rightarrow \pi^0 + \pi^0$ decay, a violation which may occur predominantly in the I = 2 final state of the mesons (π), follows naturally on the basis of a previously proposed theory. Also further calculations on $|\eta_{00}/\eta_{+-}|$ and the phases of η_{+-} and η_{00} using the experimental rate for $K^+ \rightarrow \pi^+ + \pi^0$ decay as input information are presented. (J.F.P.)

31625 PHENOMENOLOGICAL LEPTON MASS FORMULAS AND SYMMETRY GROUPS. Achasov, N. N. (Inst. of Mathematics, Moscow). Yadern. Fiz., 5: 1110-11(May 1967). (In Russian).

A possible group nature of the lepton mass formulas is considered. (auth)

31626 GEOMETRIES AND SPACE–TIME SYMMETRIES. Zumino, B. (New York Univ., New York). Nuovo Cim. (1), Suppl., 4: 384-413(1966).

From Pisa Symposium on Natural Philosophy, Pisa, Italy, Sept. 17–21, 1964. See CONF-640915.

The formal description of the commonly accepted space–time symmetries and the interconnection between them are reviewed. Also the meson (K_μ^0) experiment and some of its interpretations are discussed. (J.F.P.)

Applications (Strong)

31627 (INP-541/PL) A NOTE ON THE DISPERSIVE CALCULATION OF SYMMETRY BREAKING CORRECTIONS TO STRONG COUPLING CONSTANTS. Kwiecinski, Jan (Institute of Nuclear Research, Krakow (Poland)). Apr. 1967. 14p. Dep.

The dispersive method is proposed for calculating the symmetry breaking corrections to strong coupling constants. The method is based on the dispersive representation of the suitably chosen matrix elements of current divergences. Approximation of these matrix elements in the limit of vanishing four-momentum connected with currents by nearby poles leads to group theory results for strong coupling constants. Corrections come from distant singularities and are presented in the form of dispersive sum rules. The method is illustrated on an example of BBP coupling in broken SU(3) symmetry. (auth)

31628 BOSON RESONANCES. Goldhaber, Gerson (Univ. of California, Berkeley). pp 103-45 of Proceedings of the XIIIth International Conference on High-Energy Physics Held at Berkeley, California, August 31–September 7, 1966. Berkeley and Los Angeles, Calif., University of California Press, 1967.

See CONF-660808.

Well-known octet or nonet assignments of the boson resonances are used for an over-all view of the boson resonances, and these resonances are discussed in the framework of this grouping. These effects for which no SU(3) grouping is available are grouped phenomenologically. The topics covered are the pseudoscalar, vector, and $J^P = 2^+$ nonets, the quark–antiquark model, possible 1^+ axial vector nonet, scalar mesons, and evidence for two C = –1 mesons ($J^P = 1^+$ or 2^-). Also nonstrange resonances in the 1650-MeV mass region, missing-mass spectrometer experiments and evidence for higher-mass bosons, more complex quark structures, and more strange bosons are considered. (J.F.P.)

31629 SYMMETRIES AND THE STRONG INTERACTIONS. Dalitz, R. H. (Oxford Univ.). pp 215-38 of Proceedings of the XIIIth International Conference on High-Energy Physics Held at Berkeley, California, August 31–September 7, 1966. Berkeley and Los Angeles, Calif., University of California Press, 1967.

See CONF-660808.

Higher symmetries, the nonrelativistic quark model, the search for quarks, mesonic and baryonic states, higher representations for excited mesonic and baryonic states, and meson mixing angles are covered in the discussion of symmetries and the strong interactions. (J.F.P.)

31630 PREDICTIONS OF THE TWELVE-DIMENSIONAL GROUPS AND NUCLEON–NUCLEON SCATTERING. Arndt, R. A.; Moravcsik, M. J.; Wright, R. M. (Univ. of California, Livermore). Nuovo Cim. (10), 49A: 606-13(June 21, 1967). (UCRL-70054).

Predictions of the various twelve-dimensional groups such as SU_{12}, M_{12}, $\bar{U}_{12}$, and of the hybrid coplanar subgroup $U_3 \times U_3$ for the vanishing of one of the invariant amplitudes of nucleon-nucleon scattering are compared directly with the values of that invariant amplitude at a large range of energies and angles, as obtained from the energy-dependent modified analysis of nucleon-nucleon scattering data. There is a complete disagreement between the prediction of group theory and the experimental values. (auth)

31631 PARAQUARK DYNAMICS OF BARYONS AND RESONANCES. Mitra, A. N. (Delhi Univ.). Ann. Phys. (N.Y.), 43: 126-57(June 2, 1967).

A three-body formalism, within a nonrelativistic quark (Q) model, is developed for a dynamical treatment of baryons and their resonances as bound 3Q-systems, via Q-Q interactions operating through a Schrödinger equation, with all degrees of freedom (space, spin and unitary spin) taken into account. The main assumptions are parastatistics, and operation of Q-Q forces in s- and p-waves only. A detailed classification of the various 3Q-states of the correct symmetry is obtained in terms of (LSJ) assignments as well as SU(3) multiplet structures, using the symmetric (S), antisymmetric (A), and mixed (M) representations of the permutation group of three objects. The Schrödinger equations for the spatial parts of the 3Q-wavefunctions are found to separate into those for S, M, and A types for different values of L, in the limit of "full degeneracy" represented by spin and SU(3)-spin-independent Q-Q potentials in s- and p-waves. The group structures generated by these equations are precisely those of SU(6) ⊗ O(3). The further assumption of separable forms for the potentials, leads to coupled one-dimensional equations for certain "spectator functions" associated with the spatial wavefunctions. For the s-wave force which strongly generates even-parity (L = 0) states, and only weak $L^P = 1^-$ states, these kernels are attractive for S, but repulsive for M functions of $L^P = 0^+$. The p-wave interaction, on the other hand, strongly generates both even- and odd-parity states. For $L^P = 1^-$ states, M and A functions have attractive and repulsive kernels, respectively. The opposite holds for even-parity states, with A functions of $L^P = 1^+$ and 0^+; having attractive and repulsive kernels, respectively. A p-wave spin-orbit force is incorporated in the formalism and shown to break up the supermultiplets into SU(3) multiplets for which approximate but explicit mass formulas are derived. The main results of experimental interest are the following: a dynamical realization of the 56 states of baryons via S-functions of $L^P = 0^+$; a (70,3) representation of SU(6) ⊗ O(3), via M-functions of $L^P = 1^-$ of the negative parity baryon states whose SU(3) multiplet structure is in qualitative accord with Dalitz' analysis of experimental data, and a (20,3) representation for $L^P = 1^+$ states of which the lowest lying ones are an octet and a singlet, each of $J^P = \frac{1}{2}^+$, thus providing a dynamical explanation of the "Roper" resonance and predicting a new singlet in the "low"-mass region. (auth)

31632 SU(2), SU(3). PART IV. Gyoergyi, Geza (Central Inst. of Physical Research, Budapest). Fiz. Szemle, 17: 120-6 (Apr. 1967). (In Hungarian).

Identification of the spin multiplets which define the fine struc-

ture of atomic spectra, is based on the approximate spin independence of the forces acting on atomic electrons. The charge multiplets of the nucleus exhibit a close similarity with the atomic spin multiplets. According to the charge-independence theory, the nuclear forces acting on protons having identical states are identical; differences between the behavior of different types of particles are due to differences in mass, proton charge and magnetic moment. About 30 years ago, E. Wigner examined the nuclear spectroscopic consequences of the assumption that the forces are both spin and charge-independent. This problem was reviewed by making use of the Jordon-Wigner operators describing the proton and neutron in connection with the isospin concept. The derived Wigner supermultiplets are illustrated on the ^{8}Be nucleus. Similar considerations are used for discussing the SU(6) symmetry, leading to the hadron supermultiplet theory. (Review article). (TTT)

Quantum Field Theories

Refer also to abstract 31565.

31633 CRITICAL ANALYSIS OF CHARGE DENSITY OF KLEIN-GORDON FIELDS. Gerlach, Bernd; Gromes, Dieter; Petzold, Joachim (Univ., Marburg, Ger.). Z. Phys., 202: 401-11(1967). (In German).

It is proved that the well-known expression for the charge density S^0 can be indefinite even for the positive frequency part of the general solution. Therefore it must be rejected. (auth)

31634 FUNDAMENTAL THEORETICAL QUESTIONS. Froissart, M. (CEN, Saclay, France). pp 13-25 of Proceedings of the XIIIth International Conference on High-Energy Physics Held at Berkeley, California, August 31-September 7, 1966. Berkeley and Los Angeles, Calif., University of California Press, 1967.

See CONF-660808.

The main field of activity regarding the fundamentals of theory are reviewed, and a logical map showing the relations of the fundamentals of theory is given. Field theory, analyticity on the mass shell and on the mass shell causality, asymptotic theorems, and S-matrix theory are covered. (J.F.P.)

31635 CONVERGENT FIELD THEORY. Delbourgo, R.; Salam, A.; Strathdee, J. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Lett., 24B: 622(June 12, 1967).

It is suggested that three-dimensional electrodynamics may provide a useful and nontrivial model in which to study some of the currently interesting problems of elementary particle theory. (auth)

31636 LIMITS OF SEQUENCES OF NORMAL STATES. dell'-Antonio, G. F. (Univ. of Naples). Commun. Pure Appl. Math., 20: 413-29(May 1967).

Some general properties of convergent sequences of normal states and of their limits are analyzed. These sequences are used as a device for the construction of new representations of the relevant physical system for quantum field theory and statistical mechanics based on the algebraic structures of these theories. The physical justification for this analysis is the search for conditions under which the new representation is in some way equivalent to the representation which one started. (J.F.P.)

31637 FIELD-THEORETICAL METHODS IN PHYSICS. Bogoliubov, N. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Nuovo Cim. (1), Suppl., 4: 347-68(1966).

From Pisa Symposium on Natural Philosophy, Pisa, Italy, Sept. 17-21, 1964. See CONF-640915.

The development and formulation of quantum field theory is reviewed. This development begins with quantum electrodynamics and includes the renormalization procedure, scattering amplitudes, various axioms of quantum field theory, dispersion relations, elementary particles and resonances, SU(3), and the degeneracy of the vacuum state for symmetry-breaking interactions. (J.F.P.)

Scattering Theory

Refer also to abstracts 31611 and 31700.

31638 (LPTHE-TH-189) DISCRETE IMPACT PARAMETER REPRESENTATION OF THE SCATTERING AMPLITUDE. Chadan, K. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). Feb. 1967. 18p. Dep.

The impact parameter representation introduced recently by Predazzi, and Adachi and Kotani, is analyzed in detail. It is shown rigorously that, contrary to what has been often used in practical applications, an exponential or faster decrease of the "impact parameter amplitude," when the impact parameter becomes very large, is not allowed. On the other hand, the impact parameter representation is found to be rigorously equivalent to an infinite discrete sum over discrete values of the impact parameter b: $b_n = n\pi/2p$, p being the momentum in the cm system. According to what one is willing to admit for the asymptotic behavior of the impact parameter amplitude, one gets either a particular formula or the more general formula which is valid in all cases. At any rate, one sees that the impact parameter is somehow "quantized." The infinite sums look very similar to the usual partial-wave expansions. The functions $C_n(y)$ and $D_n(y)$, $y = \sin(\theta/2)$, which enter into these sums, are studied to some extent, and different expression for them is given. It is also found that they satisfy an inhomogeneous second order differential equation. The only assumption made throughout the paper is that the scattering amplitude has a continuous first derivative with respect to $\sin\theta/2$ on the closed interval [0,1]. (auth)

31639 DIFFICULTY IN THE INFINITE-MOMENTUM-LIMIT METHOD RELATED TO LOCALITY. Gervais, J.-L. (New York Univ.). Phys. Rev. Lett., 19: 50-3(July 3, 1967).

The proof of the Fubini-Dashen-Gell-Mann sum rule from the infinite-momentum limit is studied again taking the locality of the currents into account. It is shown that the sum rule cannot be derived from the $p \to \infty$ method proposed by Dashen and Gell-Mann. (auth)

31640 CONDENSATION OF REGGE CUTS, VANISHING TOTAL CROSS SECTIONS, AND TWISTING TRAJECTORIES. Srivastava, Yogendra (Univ., Rome, Northeastern Univ., Boston). Phys. Rev. Lett., 19: 47-50(July 3, 1967).

A proposal is made to resolve the problem that a Pomeranchuk pole, with $\alpha_P(0) = 1$, generates an infinite number of Regge cuts all condensing to $J = 1$ (at $t = 0$), which would give rise to an essential singularity, by a simple mechanism. One introduces some parent Regge poles to provide the most dominant singularity in the J plane (for a given process). If $\alpha_P(0) = 1-\epsilon$, where $\epsilon > 0$, then all successive cuts are displaced to $\alpha_c(n)(0) = \alpha(0) - n\epsilon$, which tends to $-\infty$ as $n \to \infty$. (J.F.P.)

31641 ANALYTICITY IN THE t-PLANE AND THE EXPONENTIAL GROWTH OF THE SCATTERING AMPLITUDE. Logunov, A. A.; Mestvirishvili, M. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett., 24B: 620-2(June 12, 1967).

It is shown that if the large-angle scattering amplitude has certain analytic properties in the t-plane and decreases exponentially at high energy it has an essential singularity at infinite s. (auth)

31642 DISPERSION MODEL OF SCATTERING AT SMALL PULSE TRANSMISSION AND HIGH ENERGIES. Azimov, S. A.; Arushanov, G. G.; Rasulkulov, M. S.; Khalmuradov, R. S. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uz. SSR, Ser. Fiz.-Mat. Nauk, No. 2, 68-9(1967). (In Russian).

A dispersion model of elastic scattering at low-momentum transfer and high energy using the scattering amplitude $F(s,t)$ was studied. The experimental data showed that $t_0 \simeq 0.2$ $(GeV/c)^2$ in the case of pp scattering and $t_0 \simeq 0.3$ $(GeV/c)^2$ in the case of πp-scattering. It is shown that the suggested dispersion mode is more real than that of the P. T. Matthews et al. (Nuovo Cim. 21, 1963, 823). (R.V.J.)

31643 COMPLETENESS OF THE PERTURBATION THEORY AMPLITUDES IN AMPLITUDE SPACE. Petrina, D. Ya. (Inst. of Mathematics, Kiev). Ukr. Mat. Zh., 19: No. 3, 62-78(1967). (In Russian).

It has been established earlier that the scattering amplitude for the $1 + 2 \to 3 + 4$ processes consist of holomorphic functions within a Lehman ellipse. For certain models, e.g., nonrelativistic scattering, the full scattering amplitude at a sufficiently low coupling constant g may be defined on the basis of the Lehman ellipse. It is shown that the system of equations $f^n(\cos\theta)$, $n = 0, 1, 2\ldots$ for both relativistic and nonrelativistic cases is complete in the amplitude space, or more exactly, it is possible to approximate any given function $f(\cos\theta)$ which is holomorphic in the Lehman ellipse, at any desired precision, with the linear combination of a finite number of $f^n(\cos\theta)$ functions, in the sense of the $L_2(-1,1)$ metrics. The method developed by A. I. Markushevich and M. G. Khaplanov was used for proving the derivation. (TTT)

31644 COMPLEX DOUBLE POLES IN THE PROPAGATOR AND SPECTRAL CONDITION. Lukierski, J. (Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 15: 217-22 (1967).

It was deduced that the complex first order pole, characterizing the unstable particle, can be generalized to the complex secondary order pole in the case in which the parameters determining the double pole are selected consistent with the required conditions. Calculations were made of two poles with identical complex mass.

Correlation of two parameters describing double poles and asymptotic behavior of the vertex portion was analyzed. (R.V.J.)

Particle Accelerators

Refer also to abstracts 30746, 30765, 31707, 31734, 31781, and 31837.

31645 (AERE-M-1558) A ROTATABLE SWITCHING MAGNET FOR THE HARWELL VARIABLE ENERGY CYCLOTRON. Hansford, R. N. (Atomic Energy Research Establishment, Harwell (England)). Mar. 1965. 15p. Dep. CFSTI.

A switching magnet is described for bending beams of a stiffness of about 510 kilogauss x inches through angles up to ±73°. It is shown that a rotatable magnet with oval poles is more economical than a rigid one with circular poles. The magnet yoke is specially constructed to allow the poles to move relative to the multi-way vacuum vessel which is connected rigidly to the flight tubes. (auth)

31646 (ANS-SD-3) PROCEEDINGS OF THE SPECIAL SESSIONS ON ACCELERATOR SHIELDING PRESENTED AT THE 1965 WINTER MEETING, WASHINGTON, D. C., NOVEMBER 15, 1965. Greenborg, J.; Beyster, J. R. (eds.) (American Nuclear Society, Hinsdale, Ill.). Feb. 15, 1966. 280p. (CONF-651101-(Suppl.1)). ANS.

Separate abstracts were prepared for 6 of the 12 papers presented. Six papers were previously included in NSA. For abstract numbers of these papers see abstracts 20: 5927, 7674, 10223, 32549, 44057, and 21: 21015. (B.G.D.)

For abstracts of individual papers see: 31647–31650, 31734, and 31735.

31647 (ANS-SD-3, Session 2, Paper 2) DISCUSSION ON SOME OF THE PROBLEMS ASSOCIATED WITH AN INTENSE 14-MeV NEUTRON FACILITY. Groce, D. E. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). 54p.

The energy spectrum of reflected neutrons from the concrete walls of the 14-MeV neutron source facility HENRE is investigated. Suggestions are made on means for reducing the intensity of the room-return neutrons. The vital problem of neutron activation of the enclosing interior surfaces of the facility and the resulting residual γ radiation is discussed. Recommendations for its reduction and minimization are made. (B.G.D.)

31648 (ANS-SD-3, Session 2, Paper 4) STRAY NEUTRON SPECTRA AT LARGE PULSED PARTICLE ACCELERATOR SITES. O'Brien, K.; Sanna, R.; Alberg, M.; McLaughlin, J. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). 23p.

A method to obtain spectral information of stray neutrons applicable to the range above 0.5 MeV using nuclear emulsions was developed. The data analyses employed to yield neutron spectra are discussed. (B.G.D.)

31649 (ANS-SD-3, Session 2, Paper 8) SHIELDING OF BREMSSTRAHLUNG FROM AN ELECTRON ACCELERATOR TARGET. Barrett, M. J. (Exotech, Inc., Alexandria, Va.). 6p.

The production of bremsstrahlung photons by electron accelerator beams provides one of the more significant problems in accelerator shielding. To begin an analysis of the shielding requirements, one must determine the characteristics of this source. Then, the structures around the source are designed for acceptable resistance to heat generation. A shield is next, to meet the health physics limitations during accelerator operation. Finally, the effects of residual radiation on the operation of the facility are to be determined and minimized where feasible. The approach developed for each of these problems is presented. (auth)

31650 (ANS-SD-3, Session 2, Paper 9) RADIATION SHIELDING CONSIDERATIONS FOR TANDEM ACCELERATORS. Burrill, E. Alfred (High Voltage Engineering Corp., Burlington, Mass.). 5p.

Various aspects of radiation shielding for tandem accelerators are discussed. These are typical radiation intensities, suggested concrete wall thicknesses, and trends of production and attenuation of x rays and neutrons. (B.G.D.)

31651 (BNL-11394) SUPERCONDUCTING MAGNETS FOR BEAM HANDLING AND ACCELERATORS. Sampson, W. B. (Brookhaven National Lab., Upton, N. Y.). [1966]. 12p. (CONF-670705-3). Dep. CFSTI.

From 2nd International Conference on Magnet Technology, Oxford, England.

The design of superconducting beam handling magnets is discussed for two general types: dipole for momentum selection and quadrupoles for beam focusing. Accelerator superconducting magnets are then investigated for fixed field machines and synchrotrons. (B.G.D.)

31652 (BNL-11469) A METHOD FOR THE CALCULATION OF BEAM ORBITS IN THE AGS. Vogel, U. (Brookhaven National Lab., Upton, N. Y.). June 1, 1967. Contract AT-30-2-GEN-16. 17p. Dep. CFSTI.

A method is described by which the beam orbits in the AGS can be calculated by a computer when the beam deflecting fields are assumed to be known. (B.G.D.)

31653 (BNL-11493) AGS INJECTOR BEAM MONITORING SYSTEM. Otis, A.; Larson, R.; Lockey, R.; DeVito, B.; van Steenbergen, A. (Brookhaven National Lab., Upton, N. Y.). June 1, 1967. 29p. Dep. CFSTI.

The performance of the AGS depends critically on the linac beam characteristics such as beam intensity, proton momentum, momentum spread and beam transverse phase space distribution. These parameters are measured by pulse deflection of the 50-MeV proton beam into a separate analyzing channel in which continuous beam analysis and monitoring is possible without interruption of regular AGS operation. In addition to a general description of the linac-synchrotron beam transport and analyzing system, details of the momentum spread and monitoring system are presented. (auth)

31654 (CEA-R-3112) ETUDE ET REALISATION D'UN ACCELERATEUR LINEAIRE D'ELECTRONS. DYNAMIQUE DES ELECTRONS ACCELERES. (Study and Realization of an Electron Linear Accelerator: Dynamics of Accelereted Electrons). Bernard, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1967. 192p. (In French). Dep.

Thesis. Submitted to Univ., Paris.

The theoretical characteristics of the electron linear accelerator are: 30 MeV for the energy W_S and 250 mA for the peak current I_c. The maiff utilization is the intense production of fast neutrons by the reactions (γ,n) and (γ,f) induced in a target of natural uranium by the accelerated electrons. The study and the realization of the accelerator are discussed and a new equation of dispersion is established analytically when the guide is loaded with round-edged irises. The relation is compared with the equation established by Chu and Hansen, Walkinshaw, Kvasil in the case of a guide loaded with flat-edged irises. The experimental and theoretical curves of dispersion are compared. The accuracy of every relation of dispersion is estimated. (auth)

31655 (LA-3241) PHERMEX: A PULSED HIGH-ENERGY RADIOGRAPHIC MACHINE EMITTING X-RAYS. Venable, Douglas; Dickman, D. O.; Hardwick, J. N.; Bush, E. D. Jr.; Taylor, R. W.; Boyd, T. J.; Ruhe, J. R.; Schneider, E. J.; Rogers, B. T.; Worstell, H. G. (Los Alamos Scientific Lab., N. Mex.). May 15, 1967. Contract W-7405-eng-36. 252p. Dep. CFSTI.

The design aspects and the capability of PHERMEX as an electron accelerator and a source of penetrating gamma rays for flash radiography are discussed. (B.G.D.)

31656 (LA-3712) QUARTERLY STATUS REPORT ON THE MEDIUM-ENERGY PHYSICS PROGRAM FOR THE PERIOD ENDING APRIL 30, 1967. (Los Alamos Scientific Lab., N. Mex.). May 1967. Contract W-7405-eng-36. 47p. Dep. CFSTI.

The medium-energy physics program at LASL which deals with the new Los Alamos Meson Physics Facility is discussed. The topics covered the injector system, accelerator structures, rf power sources, accelerator control and instrumentation, accelerator physics, project scheduling, and facilities planning.(B.G.D.)

31657 (LYCEN-6648) ETUDE D'UN DISPOSITIF DE PULSATION D'UN FAISCEAU DE PROTONS ISSU D'UN ACCELERATEUR VAN DE GRAAFF. APPLICATION A LA MESURE DE VIES D'ETATS NUCLEAIRES EXCITES. (Study of a Pulsation Device for a Proton Beam Emitted From a Van de Graaff Accelerator. Application to the Measurement of the Lifetimes of Nuclear Excited States). Poizat, Jean Claude (Lyon Univ. (France). Institut de Physique Nucleaire). Nov. 1966. 66p. (In French). Dep. mn.

Thesis.

After an enumeration of the various pulsation techniques for a particle beam, the principle and the development of a pulsation system based on a method by diaphragm sweeping was described. Emphasis was given to the study of focusing as it applies to obtaining short proton pulses. For the pulsation device constructed resolution time of less than two nsec was obtained. The lifetimes of the 110-keV level of ^{19}F and of the 580-keV level of ^{25}Mg were measured as 0.84 ± 0.04 and 4.97 ± 0.15 nsec, respectively. (tr-auth)

31658 (NP-16618) ENSEMBLE DE TELEMESURE DE TENSIONS ET DEBITS EN TETE D'UN ACCELERATEUR. (Telemetering Ensemble for Electric Potential and Current Flow at the Output of an Accelerator). Note Technique ACC-65/01. Fremiot, Ch.; Rocco, J. C.; Geslin, P. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Jan. 1965. 4p. (In French). Dep.

The circuit for a telemetering device for measuring potential and current flow at the output of a Van de Graaff accelerator is given and its characteristics are briefly outlined. (J.S.R.)

31659 (NP-16811) EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH ANNUAL REPORT, 1966. Twelfth Annual Report. (European Organization for Nuclear Research, Geneva (Switzerland)). 169p. Dep.

The research activities of the various divisions of CERN during 1966 are presented. The divisions are nuclear physics, synchrocyclotron, track chambers, theoretical physics, proton synchrotron, nuclear physics apparatus, data handling, intersecting storage ring, accelerator research, finance, personnel, technical services and buildings division, health physics, general safety, and central services. (B.G.D.)

31660 (RHEL/R-136, pp 3-8) MACHINE OPERATION. (Rutherford High Energy Lab., Chilton (England)).

The operation of the proton linear accelerator including fault and running time is discussed. A histogram of the hours available to experimenters is presented. The reliability and performance of various equipment are also discussed. (B.G.D.)

31661 (RHEL/R-136, pp 9-23) MACHINE IMPROVEMENTS. (Rutherford High Energy Lab., Chilton (England)).

Various improvements to the proton linear accelerator are discussed. The improvements deal with increasing beam duty cycle, increasing pulse length, power amplifier output, shielding, polarized proton source, redesign of the low energy drift space, and the rf drive chain. (B.G.D.)

31662 (RHEL/R-136, pp 24-7) ACCELERATOR PHYSICS MEASUREMENTS. (Rutherford High Energy Lab., Chilton (England)).

The equipment and technique used in beam emittance measurements on the PLA linear accelerator are discussed. (B.G.D.)

31663 (RHEL/R-136, pp 152-61) HEALTH PHYSICS. (Rutherford High Energy Lab., Chilton (England)).

Two main health physics problems associated with PLA proton linear accelerator operation are discussed. These are the leakage radiation through and over the shielding during machine operational periods and the induced activity in the machine itself and associated ancillary or experimental equipment. (B.G.D.)

31664 (SLAC-73) TWO-MILE ACCELERATOR PROJECT. Quarterly Status Report, October 1-December 31, 1966. (Stanford Linear Accelerator Center, Calif.). May 1967. Contracts AT(04-3)-400; AT(04-3)-515. 81p. Dep. CFSTI.

Various aspects of the SLAC development during the period October 1, 1966, to December 31, 1966, are discussed. These include accelerator operation, system and component operation, accelerator physics, klystron studies, mechanical engineering and fabrication, instrumentation and control, electronic engineering, counting electronics, research area developments, and physics research equipment development. (B.G.D.)

31665 (SLAC-PUB-318) NEW JOINING TECHNIQUE FOR WATER-COOLED COPPER MAGNET COILS. Gunn, Jack (California Univ., Berkeley. Lawrence Radiation Lab.); Fritzke, Gerald (Stanford Linear Accelerator Center, Calif.). June 1967. Contract AT(04-3)-515. 5p. (CONF-670705-8). Dep. CFSTI.

From 2nd International Conference on Magnet Technology, Oxford, England.

The new joining technique, fusion welding of the copper conductor for water-cooled magnet coils, is tested and a study of the effects of joint design on the strength and microstructure of a standard hollow square copper conductor is made. The results of tensile tests performed on welded copper are presented. From these tests it is evident that fusion welding with filler-metal additions produces high quality joints in a copper conductor. (J.F.P.)

31666 (SLAC-PUB-321) PARAMETERS THAT AFFECT THE ACCURACY AND SETABILITY OF A MAGNETIC FIELD IN AN IRON CORE ELECTROMAGNET. Cobb, J. K.; Jensen, D. R. (Stanford Linear Accelerator Center, Calif.). June 1967. Contract AT(04-3)-515. 9p. (CONF-670705-7). Dep. CFSTI.

From 2nd International Conference on Magnet Technology, Oxford, England.

A detailed study of the magnitude of the effects of temperature, previous history of induction, and also the time rate of current excitation on the induction and on the line integral of induction over a path through the magnet was made. Also a comparison between solid-core and laminated magnets and between large solid-core and small solid-core magnets was made. It was shown that the distribution of induction over the magnet pole is a function of excitation rate as well as excitation for magnets that are partially saturated. The location in the magnet where the induction is measured may therefore be important. The effects of previous history of induction on the setability of these magnets is also discussed. (J.F.P.)

31667 (ORNL-tr-1687) DIGITAL COMPUTATION OF THE TRAJECTORIES OF PARTICLES FOR A LIMIT TIME. Astashkina, N. V.; Vecheslavov, V. V. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). Translated for Oak Ridge National Lab., Tenn., from Preprint No. 83. 16p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

A method and results of digital computations of trajectories in a simplified field of an accelerator in the presence of cubic (with respect to the field) nonlinearity was presented. The calculations were a continuation of previous work to obtain resonance stabilization by means of specially selected nonlinearity. The results were negative. New nonlinear types of instability developed before the stabilization became effective to any degree. (B.G.D.)

31668 (SLAC-Trans-66) REPORT OF STUDY GROUP ON EXPERIMENTATION WITH MAGNETIC FIELDS AT ADONE. Amaldi, U. Jr.; O'Neill, G. K.; Petrucci, G.; Sacerdoti, G.; Schiavuta, E. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). Translated for Stanford Linear Accelerator Center, Calif., from report LNF-67/3. 72p. Dep. CFSTI. JCL $7.60 fs, $2.36 mf.

The discussion of experimentation with magnetic fields at Adone includes the experiments for which a magnetic field is needed and the resolution requirements for each class of experiments, a classification of the various types of magnetic fields whose use might be considered, the measurement precision in various types of scintillation chambers, and proposals for magnets made by various experimental groups. The magnetic systems are measured against a series of suitability criteria, and recommendations relevant to good utilization of the magnetic system are made. (J.F.P.)

31669 SIRIUS ELECTRON SYNCHROTRON OF THE TOMSK POLYTECHNICAL INSTITUTE. Vorob'ev, A. A.; Volkov, M. N.; Vlasov, A. G.; (and others) (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 2, 162(1967). (In Russian).

The development of the Sirius electron-synchrotron, with a maximum energy of accelerated electrons of 1.5 GeV, is reported. The synchrotron electromagnet is a racetrack with four linear areas, which are free from the action of the magnetic field. The weight of the active steel of the magnet is 115 tons. Copper tubes (OD, 22 mm; ID, 12 mm) were used for the windings of the electromagnet. The electromagnet is supplied with sinusoidal pulses from the capacitor battery. The maximum current and voltage are 5140 A and 12.4 kV respectively. The prf is 1 Hz, and the pulse duration is 84 msec. The vacuum chamber of the accelerator consists of four circular and four linear sections. The circular sections are assembled from porcelain units, while the linear sections are made of copper tubes 23 cm in diameter. After continuous pumping, the vacuum in the center of the circular sections reaches 3×10^{-6} mm Hg. A 5-MeV microtron with pulse current of 30 to 40 A and pulse duration of 3 μsec is used as an injector. Electron acceleration is accomplished by two toroidal resonators in which the hf voltage with an amplitude of 120 kv is excited. The resonators have Q = 2000 at an operational frequency of 36.5 mHz, and the shunt resistance is 50 kohm. The separate systems of the accelerator are controlled by a synchro-generator. The accelerator was tested at reduced electromagnetic voltage (10.4 kv instead of 12.4 kv) and with one operational resonator in which the hf voltage was 50 to 80 kV. Under such conditions, electrons acquired an energy level of 1.1 GeV with beam intensity of 1.2×10^{10} electrons per pulse (at the end of the acceleration cycle). (ATD)

31670 ON THE EXTENT TO WHICH COHERENT BREMSSTRAHLUNG FROM CRYSTALS CAN BE MONOCHROMATIZED. Bologna, G. (CNEN, Rome). Nuovo Cim. (10), 49A: 756-64 (June 21, 1967).

The degree of monochromaticity which can be preserved in a bremsstrahlung beam is investigated by observing the actual experimental conditions. The evaluation of the coherent and polarized bremsstrahlung angle and energy differential cross sections, the folding of the differential cross section with the electron distribution for multiple scattering and beam divergence, the integration of the expressions obtained, and the best choice of the crystal are given. (J.F.P.)

31671 MODEL EXPERIMENTS ON INJECTION OF POLARIZED PROTONS INTO CYCLOTRON-TYPE ACCELERATORS. Plis, Yu. A.; Soroko, L. M.; Toropkov, N. A. Zh. Tekh. Fiz., 37: 485-92(Mar. 1967). (In Russian).

Certain aspects of the neutral beam technique for injecting polarized protons into an accelerator are investigated. In this technique the polarized proton beam is neutralized by charge exchange in a hydrogen target and injected in the median plane of the accelerator, where the hydrogen atoms are stripped of their electrons by passage through a suitable foil. The present experiments were performed with an unpolarized beam of 30-keV protons, but there is given a brief theoretical discussion of depolarization in charge exchange collisions, from which it is concluded that the depolarizing factor can be kept reasonably small only by providing a magnetic field in the charge exchange chamber. The ion beam, after being focused and collimated, traversed a 35-cm-long charge exchange chamber containing hydrogen, in which there was maintained a longitudinal magnetic field. After the beam left the charge exchange chamber, the ions and atoms were separated with a transverse magnetic field and the two components of the beam were separately analyzed. The charge exchange was most efficient when the thickness of the hydrogen target was about 10^{16} atom/cm^2 and the magnetic field strength in the charge exchange chamber was about 1 kOe. The observed charge exchange efficiency as a function of the hydrogen pressure in the chamber was in good agreement with the values calculated from the cross sections tabulated by S. K. Allison (Rev. Mod. Phys., 30: 1137(1958)). From the results of the present measurements together with other data it is concluded that polarized protons could be injected by the investigated technique into a synchrocyclotron with an efficiency of 0.028%, whereas A. J. Cox et al. (Nucl. Instr. a. Meth. 18: 25(1962)) report axial injection of polarized protons (not involving neutralization) into an isochronous cyclotron with an efficiency of 5.0%. (ATD)

31672 RADIOFREQUENCY SEPARATED BEAM AT THE AGS. Foelsche, H. W. J. (Brookhaven National Lab., Upton, N. Y.); Hahn, H.; Halama, H. J.; Lach, J.; Ludlam, T.; Sandweiss, J. Contract AT(30-2)-Gen-16. Rev. Sci. Instrum., 38: 879-94(July 1967). (BNL-10855).

Spatial separation of undesired particle components from high energy kaon, pion, and antiproton beams is achieved by means of an rf separator consisting of two transverse deflectors, set 40 m apart and operated at 2.856 GHz. Elimination of two contaminants is possible if their difference in transit time between deflectors equals a multiple of one rf cycle. In the system described this occurs, for example, at 12.80, 9.04, and 7.38 GeV/c if kaons are desired. The actual useful beam system involves the magnetic optics necessary to form a momentum analyzed beam with $\Delta p/p = 1\%$ and to transport the particles over 129 m between an external target at the Brookhaven Alternating-Gradient Synchrotron and the 80-inch Bubble Chamber. The design of the magnetic optics for the momentum analysis section, the separator stage, and the post analysis section is discussed. For proper operation, the rf beam separator described requires deflectors which are capable of imparting a transverse momentum $p_T \geq 18$ MeV/c to traversing particles. A 3 m long iris-loaded structure operating in a backward wave hybrid mode with dipole character was selected. The necessary multi-MW rf pulses are generated by a microwave system which consists of a phase locked source, TWT, triode, and klystron amplifiers, as well as associated modulators. A phase servo maintains the prescribed phase relationship between deflectors. The separated beam has been tested and run as kaon and pion beams. The system has, in general, performed according to expectations. Preliminary performance data indicate for example at 12.8 GeV/c an average yield of eight K^- mesons per pulse with $0 \pm 15\%$ background. (auth)

31673 PREPARATION OF THIN SELF-SUPPORTING BERYLLIUM FOILS. Oona, H.; Rickel, D. G. (Univ. of Arizona, Tucson). Rev. Sci. Instrum., 38: 980(July 1967).

An evaporation technique is described for preparing thin self-supporting beryllium foils having thicknesses of 5 to 10 μg/cm^2, and a free circular area with a diameter of 0.63 cm. The foils are used as targets for beams of atomic and molecular ions at energies up to 2 MeV. (L.B.S.)

31674 METHOD FOR PREPARING THIN SELF-SUPPORTING Pb FILMS. Imbusch, A. (Technische Univ., Berlin). Rev. Sci. Instrum., 38: 974-5(July 1967).

An evaporation technique for preparing self-supporting lead films with thicknesses down to 250 Å is described. (L.B.S.)

31675 HIGH CURRENT TARGET DESIGN FOR ION ACCELERATORS. Seiler, R. F. (Boeing Co., Seattle); Cleland, M. R.; Wegner, H. E. Rev. Sci. Instrum., 38: 972-4(July 1967).

A high-current target for ion accelerators was designed to provide power dissipation in the vicinity of 1 to 4 kw/cm^2 by conduction cooling through some base material into a coolant medium. The basic target consists of a specially flattened 2.5 cm. o.d. copper tube with a 0.8 mm. wall thickness. Active targets were prepared by vapor depositing a thin film of titanium on the copper blanks and then loading the film with deuterium or tritium. Preliminary measurements made of yields from the D(d,n)^{3}He; T(d,n)^{4}He, and D(^{3}He,p)^{4}He reactions indicate that this target design provides an efficiently cooled substrate upon which various types of target materials can be bonded in the form of thin films. Further measurements were found necessary in order to determine the maximum power capability of this design as well as the optimum parameters necessary for the various types of target coatings that are used. (L.B.S.)

31676 QUADRUPOLE MAGNETIC LENS USING PERMANENT CERAMIC MAGNETS. Jagger, J. W.; Riley, P. J. (Univ. of Texas, Austin). Contract AT(40-1)-2972. Rev. Sci. Instrum., 38: 955-7(July 1967). (ORO-2972-8).

A quadrupole lens pair is described utilizing permanent ceramic magnets. The field gradient is 470 Oe/cm, across a 7.94-cm aperture. Variation in lens strength is achieved by driving the lenses over a mild steel magnetic shunt welded to the inside of the beam tube. The lenses are of relatively low cost, light weight, and simple construction. Of the two units described, when used at full strength, the smallest lens pair brings a 10-MeV proton beam to a focus at a distance of 4 m from it. (auth)

31677 INFLUENCE OF THE DAMPING OF THE OSCILLATIONS ON THE TRANSVERSE DISSIPATIVE INSTABILITY. Kheifets, S. A. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 2: 79-84(1967). (In Russian).

The theory of the transverse dissipative instability is generalized for the case of oscillation damping. It is shown that the damping brings stability (when the inequality $\alpha > V$ is fulfilled) even in the case when there is no spread of particle frequencies. The obtained criterion of stability is important for accelerators and electron-positron storage rings of ultrarelativistic energy. (auth)

31678 PARTICLE ACCELERATING TUBES. (to Tokyo Shibaura Electric Co.). British Patent 1,073,948. June 28, 1967. Priority date Sept. 5, 1963, Japan.

A particle accelerating tube is described which comprises an insulator cylinder located in a vacuum chamber with a series of accelerating electrodes, a source of charged particles, and a target mounted in a second vacuum chamber connected with the first through a small aperture. The purpose of the tube is to accelerate charged particles for the production of neutrons and x rays. (B.G.D.)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 31479, 31481, 31492, and 31840.

31679 (EANDC-56(U)) THREE YEAR PROGRESS REPORT OF THE ENEA NEUTRON DATA COMPILATION CENTRE, 1964-1967. Colvin, Douglas W. (European-American Nuclear Data Committee). May 1967. 16p. Dep.

The activities, organization, and services of the ENEA Neutron Data Compilation Center are outlined. (D.C.W.)

31680 (IFA-FR-57) INVARIANT IMBEDDING IN NEUTRON TRANSPORT THEORY. [Bibliography]. Rosescu, Teodor (Academia R. P. R., Bucharest. Institutul de Fizica Atomica). 1966. 12p. Dep.

References (85) for reports and journal articles dealing with the application of invariant imbedding in neutron transport theory are presented. (D.C.W.)

31681 (K-DP-2252) ON THE TREATMENT OF HYDROGEN SCATTERING IN MULTIGROUP MONTE CARLO CRITICALITY CALCULATIONS. Whitesides, G. E.; Cross, N. F. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). [1966]. Contract W-7405-eng-26. 7p. (CONF-670602-17). Dep. CFSTI.

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif.

Two methods of treating scattering by hydrogen in criticality calculations using the Monte Carlo method are briefly discussed. The results of some calculations of multiplication constants for a variety of experimentally critical systems are presented. (D.C.W.)

31682 (NP-tr-1545) BACK SCATTERING EXPERIMENTS OF HIGH RESOLUTION WITH NEUTRONS. Alefeld, B. (Technische Hochschule, Munich (West Germany). Translated by W. G. Stripp (Atomic Energy Research Establishment, Harwell, Eng.), from a German report. 10p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

A highly monochromatic neutron beam was produced with the Munich research reactor, using neutron guides and Bragg backscattering. The beam is analyzed with a second back-scattering silicon or lead crystal with a variable lattice constant. By using the beam it is possible to measure both changes in lattice constants and small changes of energy in the scattering of neutrons with a higher accuracy than was previously available. (S.F.L.)

31683 ISOLATED EIGENVALUES OF THE PARTICULAR SOLUTIONS OF THE ENERGY-DEPENDENT NEUTRON TRANSPORT EQUATION IN PLANE GEOMETRY. Collatz, S. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie, 10: 33-9(Feb. 1967). (In German).

The particular solutions of the energy-dependent neutron transport equation in plane geometry are represented by both a continuous and an isolated set of functions. The isolated functions essentially result as the eigenfunctions of an integral equation of the Fredholm type. Both the (ever finite) number and the structure of these particular solutions are studied as a function of the physical properties of the transport media. The connection between the fundamental neutron spectrum of a multiplying medium and the particular solutions is discussed. (auth)

31684 GENERAL MODAL-EXPANSION METHOD FOR OBTAINING APPROXIMATE EQUATIONS FOR LINEAR SYSTEMS. Stacey, Weston M. Jr. (Massachusetts Inst. of Tech., Cambridge). Nucl. Sci. Eng., 28: 438-42(June 1967).

A general method for replacing a rigorous equation by a set of approximate equations with a reduced number of independent variables is presented. The modal-expansion method includes, as special cases, many of the techniques employed in reactor-physics calculations: harmonic analysis, polynomial expansions, semi-direct variational methods, weighted-residual methods, region balance, etc. The mathematical significance of the procedure is discussed in terms of the representation of a linear operator equation on a linear vector space. The concept of a "best" set of approximate equations is examined with respect to certain error criteria. (auth)

31685 ON THE EXPERIMENTAL APPLICATION OF THE NEUTRON-WAVE TECHNIQUE TO THERMAL-NEUTRON SYSTEMS. Booth, R. S. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio); Hartley, R. H.; Perez, R. B. Nucl. Sci. Eng., 28: 404-14(June 1967).

A technique is presented for conducting neutron-wave experiments in thermal-neutron systems using either a sinusoidally modulated or a pulsed source of thermal neutrons. A neutron source suitable for this experiment is described, data-accumulation criteria are presented, and the electrical systems used for collection are discussed. A specific experiment with graphite is reported, and the discussion of data analysis is carried through the experimental determination of this system's dispersion law. It is found that, in general, a pulsed source of thermal neutrons is more suitable for neutron-wave experimentation than a sinusoidally modulated source. Confirmation is given to the theoretical prediction that diffusion and thermalization parameters can be measured by this technique over a relatively wide range of frequency without significant higher space- and energy-mode contamination. The values obtained for the diffusion and thermalization parameters for graphite of density 1.60 g/cm^3 were $\alpha_0 \pm 91. \pm 1$ sec^{-1}, $D_0 = 2.16 \pm 0.01 \times 10^5$ cm^2 sec^{-1}, $C_0 = 39. \pm 2 \times 10^5$ cm^4 sec^{-1}, and $F_0 = 12. \pm 2 \times 10^7$ cm^6 sec^{-1}. (auth)

31686 PROPERTIES OF THE RELAXATION LENGTHS IN P_L, DOUBLE-P_L, AND ANGLE-SPACE SYNTHESIS-TYPE APPROXIMATIONS. Kaplan, S. (Westinghouse Electric Corp., West Mifflin, Pa.). Contract AT(11-1)-Gen-14. Nucl. Sci. Eng., 28: 456-8(June 1967). (WAPD-T-1952).

It is demonstrated that, for a large category of angle-space synthesis transport approximations, the relaxation lengths appear in positive-negative pairs and that they also obey a nesting property. This demonstration is of interest because it proves that those properties are present in some new cases (e.g., double P_L), and because, for the P_L cases where the properties were known to hold, it provides an alternate proof which may be more illuminating in that it utilizes only the essential structure of the P_L equations and not their details. (S.F.L.)

31687 EVIDENCE OF KOCINSKIS SPIN CORRELATION FUNCTION FROM CRITICAL MAGNETIC SCATTERING BY NICKEL. Stump, N.; Maier, G. (Kernforschungsanlage, Juelich, Ger. Landes Nordrhein-Westfalen, Juelich, Ger.). Phys. Lett., 24A: 625-6(June 5, 1967).

A measurement of critical magnetic scattering at extremely small momentum transfer is reported. A shift in maximum intensity was observed. The correlation function given by Kocinski enables its interpretation. (auth)

31688 ORIGIN AND CHARACTERISTIC VALUE PROBLEM OF NEUTRON TRANSPORT THEORY. Marti, Juerg T. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). Z. Angew. Math. Phys., 18: 247-59(Mar. 25, 1967). (In German).

A proof based on the theory of semi-groups in Hilbert space is given for the existence of a unique solution of an abstract Cauchy problem arising in the transport theory of mono-energetic neutrons, corresponding to the time-dependent linear Boltzmann equation in the general three-dimensional geometry. The spectral properties of the Boltzmann operator are investigated. An explicit representation of the solution is obtained by the perturbation theory for semi-groups of linear operators, and, alternatively, an expansion in a series of eigenfunctions is given. (auth)

31689 CONTRIBUTION TO THE NUMERICAL SOLUTION OF THE THREE-DIMENSIONAL NEUTRON DIFFUSION EQUATION. Nuding, E.; Warmbold, I.; Ehret, B.; Wolf, H.-P. (Siemens Aktiengesellschaft, Erlangen, Ger.). Nukleonik, 9: 330-2(Apr. 1967). (In German).

With the help of a special representation of large matrices in the calculator it is possible to solve effectively and with low programming expenditure a series of reactor physics problems involving numerous calculations. The method represented in principle in these studies is based on the fact that the large matrices occurring in these problems indicate a problem dependent "distinctive structure." The method was used on the example of the three-dimensional neutron diffusion equation. Simple calculation examples show the suitability of the method for common usage. The work is a further development of a program system described earlier. (tr-auth)

31690 INVESTIGATION OF THE ENERGY-DEPENDENT MILNE PROBLEM FOR THERMAL NEUTRONS IN WATER. Renz, Klaus (Kernforschungsanlage, Juelich, Ger.). Nukleonik, 9: 312-22(Apr. 1967). (In German).

The perturbation of the energy distribution of thermal neutrons by the unhindered outflow at the boundary of a moderator, the so called Milne problem, was investigated. Measurements of the spectrally sensitive activation behavior of ^{176}Lu and ^{63}Cu show before a completely absorbing Cd screen in water an increase of the measurement magnitude of about 11.1%. The activation was done

in the tank of the FRJ-1 reactor. The site and energy-dependent neutron flux was obtained by numerical integration of the transport equation with source term. The comparison of theory and experiment shows very good agreement for the activation behavior in the case of the Melkin nucleus but refutes the free proton gas model. From the angle-dependent measurements of Kallfelz, the outflow spectrum averaged over all directions calculated. Between 0.02 and 0.13 eV there is agreement with the spectrum calculated by the use of the Melkin nucleus; under 0.02 eV, however, the measured results decrease sharply. (tr-auth)

31691 APPROXIMATE SOLUTIONS OF THE NEUTRON TRANSPORT EQUATION IN TWO AND THREE DIMENSIONAL SYSTEMS. Williams, M. M. R. (London Univ.). Nukleonik, 9: 305-12(Apr. 1967).

By applying the ideas of asymptotic transport theory, it has been possible to reduce the three dimensional, energy-dependent Boltzmann equation to a one-dimensional form. This one-dimensional equation contains, however, details of the complete three dimensional angular distribution. Essentially, the idea is to to treat one of the space dimensions exactly and approximate the other two by the exp (i B · R) assumption. The general result is applied to several well known situations in a finite prism. For example, the Milne problem is discussed and the effect of transverse leakage on the extrapolated endpoint and surface angular distribution is calculated. Some exact results are presented for the one-speed Milne problem where it is found possible to solve the problem via the Wiener-Hopf technique. Also discussed is the diffusion length problem, with particular reference to the competing effects of positive flux curvature in the transverse directions, and exponential relaxation along the axis of the prism. Some results on the limit point behavior of the discrete space eigenvalues, and predictions about the anisotropy of diffusion heating in a finite prism, are made. (auth)

31692 MEASUREMENT OF AVERAGE TOTAL CROSS-SECTION FLUCTUATION FOR Al AT 14 MeV NEUTRON ENERGY. Angeli, I.; Hunyadi, I. (Inst. of Nuclear Research, Debrecen, Hungary). Acta Phys. Acad. Sci. Hung., 23: 123-4(1967).

The squared average of total 14-MeV neutron cross-section fluctuations for Al was obtained using the transmission method suggested by Lee and Tsukada [Phys. Letters 11: 141(1964)]. (S.F.L.)

31693 CALIBRATION OF THE ALDERMASTON ^{240}Pu SPONTANEOUS FISSION NEUTRON SOURCE. Fieldhouse, P.; Culliford, E. R.; Mather, D. S. (Atomic Weapons Research Establishment, Aldermaston, Eng.). J. Nucl. Energy, 21: 131-55(Feb. 1967).

The source was manufactured from ^{239}Pu enriched with 24 percent of ^{240}Pu, and was cast in the form of a homogeneous sphere 3 cm in diameter, clad in gold. Spontaneous fission accounts for more than 97 percent of the output, the remainder being contributed by (α,n) reactions. Calculations show that the energy spectrum of the emergent neutrons differs only slightly from the ^{240}Pu fission spectrum. Absolute determinations of the source output were made using three independent flat response detectors; namely, the Aldermaston Oil Bath, standardized by the T(d,n)^{4}He reaction; the Harwell Boron Pile, standardized by the D(γ,n)H reaction; and the National Physical Laboratory Manganese Sulphate Bath, the efficiency of which is determined by adding to the inactive bath a known amount of ^{56}Mn activity. Details of these three calibrations are given, with particular reference to the Oil Bath method, since this has not been described in the literature to the extent of the other two methods. Excellent agreement was obtained, a weighted average giving a mean neutron emission rate of $6.562 \pm 0.029 \times 10^4$ n/sec, referred to January 1964. The source output is increasing slightly with time, at a rate of about 0.1 percent per year, the present strength being 6.579×10^4 n/sec (June, 1966). (UK)

31694 A SIMPLE MODEL FOR THE INELASTIC SCATTERING OF FAST NEUTRONS. Cadilhac, M.; Pujol, M. J. Nucl. Energy, 21: 58-63(Jan. 1967).

The model proposed allows the use of a continuous energy variable and may lead to a better physical understanding of the behavior of fast neutron multiplying media, without introducing any significant error in the results. (UK)

31695 SOME COMPARISONS BETWEEN PREDICTED NEUTRON SPECTRA AND DIFFERENTIALLY MEASURED SPECTRA IN HYDROGENOUS SOLUTIONS CONTAINING VARIOUS ABSORBERS. Harper, R. G. (Rolls-Royce Ltd., Derby, Eng.). J. Nucl. Energy, 21: 55-7(Jan. 1967).

A comparison is made of experimental spectra and spectra calculated using several scattering laws within the framework of multigroup transport theory. Preliminary conclusions are drawn from the work. (UK)

31696 A CALCULATION OF THE AGE AND FAST EFFECT IN BERYLLIUM AND BERYLLIUM OXIDE. Amster, H. (Univ. of California, Berkeley); Perkins, S. T. J. Nucl. Energy, 21: 263-70(Mar. 1967).

The age and fast effect for fission neutrons in Be and BeO were derived from a multigroup solution of the moments equations. Recent nuclear data, including that known for the ^{9}Be(n,2n) reaction, were incorporated. All neutron degradation processes were described exactly within the framework of multigroup theory, including energy-angle correlations. The analysis has shown that the age and fast effect are not strongly dependent upon either the secondary neutron spectra from the ^{9}Be(n, 2n) reaction, nor its large anisotropy in the laboratory system. Significant uncertainties in the nuclear data still remain; these uncertainties however, do not seem capable of explaining the persisting difference of 12 per cent between calculated and measured ages in Be. (UK)

31697 TWO-GROUP TRANSPORT THEORY. Siewert, C. E.; Shieh, P. S. (North Carolina State Univ., Raleigh). J. Nucl. Energy, 21: 383-92(May 1967).

Case's method of singular normal modes is used to construct solutions to the two-group neutron transport equations in one dimension. Full-range completeness and orthogonality theorems for these eigensolutions are proved, and the necessary normalization integrals are presented. In addition, functions orthogonal to the degenerate eigensolutions are developed so that all expansion coefficients can be found by simply taking scalar products. As an example of the method, the exact solution for the infinite-medium Green's function is obtained. (UK)

31698 CONCERNING A RESULT OF L. TAKACS ON NEUTRON MODERATION. Wilkins, C. (Univ. of Auckland, New Zealand). Stud. Sci. Math. Hung., 1: No. 1-2, 27-9(1966).

Let μ_x denote the number of collisions undergone by a neutron in the lethargy interval (u_0, x), where u_0 is the initial lethargy. Then the expected value of $\mu_x(\mu_x-1)\dots(\mu_x-j+1)$, conditional upon absorption not occurring, and for arbitrary types of scattering, may be written as $(j!)\int_{u_0}^{x} F(u_j; u_0)\int_{u_1}^{x} F(u_2; u_1)\dots\int_{u_{j-1}}^{x} F(u_j; u_{j-1})\, q(x; u_j) \times du_j du_{j-1}\dots du_1/q(x; u_0)$ where $F(x; y)$, $q(x; y)$ are, respectively, the collision density and the slowing-down density at x due to a monoenergetic source at lethargy y. (auth)

31699 DIFFUZIYA NEITRONOV V GETEROGENNYKH SREDAKH. (Nuetron Diffusion in Heterogeneous Media). Grigor'ev, I. S.; Novikov, V. M. Moscow, Atomizdat, 1966. 176p.

The diffusion of monoenergetic neutrons in heterogeneous media was examined. Methods of homogenization of heterogeneous periodic systems, formed from a sufficiently large number of elementary cells, were described. Emphasis was given to the effective anisotropy of the neutron diffusion in heterogeneous media. Experimental data on this question were reported. (tr-auth)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 31733, 31736, 31737, 31739, 31829, and 31838.

31700 (LA-3706) OFFSHELL $^1S_0$ PROTON–PROTON SCATTERING MEDIATED BY A SOFT CORE POTENTIAL. Brolley, John E.; Morrison, L. Kent (Los Alamos Scientific Lab., N. Mex.). May 1967. Contract W-7405-eng-36. 9p. Dep. CFSTI.

A soft-core potential was applied to offshell $^1S_0$ p-p scattering at low energy. The Coulomb field was assumed to be screened by the electrons of the hydrogen atoms in the target and was therefore cut off at the radius of the hydrogen atom. Cross sections and phase shifts were calculated and were compared with experimental data. (D.C.W.)

31701 (NP-16819) RELATIVISTIC TREATMENT OF MUON CAPTURE IN DEUTERIUM. Application to the Determination of Neutron–Neutron Scattering Length and Effective Range. Cremmer, E. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). May 1967. 23p. (TH-203). Dep.

A relativistic calculation of muon capture in deuterium is performed. The important effect of hyperfine structure is treated relativistically. The aim of this work is a determination of neutron-neutron scattering length and effective range. Vertex functions are used to describe the proton-neutron-deuteron vertex and the Omnés method to compute the final state interaction. It is shown that an accuracy of 2.5% in spectrum and capture rate must allow a determination of r_{0s} and a_s with an accuracy of, respectively, ±0.2 Fermi and ±0.7 Fermi. (auth)

31702 (TID-23841) $^3He(^3He,t)3p$ AT 44 MeV. Trombrello, T. A. (California Inst. of Tech., Pasadena); Slobodrian, R. J. (California Univ., Berkeley. Lawrence Radiation Lab.). Mar. 1967. Contract Nonr-220(47). 10p. (AD-650970). Dep. CFSTI.

Triton spectra from the reaction $^3He(^3He,t)3p$ were measured at a bombarding energy of 44 MeV for laboratory angles between 6° and 25°. These spectra are quite featureless and show no indication of either a 3p final state interaction or of a strong sequential decay mode. (auth)

31703 n-d TOTAL CROSS SECTION, THREE-NUCLEON PROBLEM, AND THE DINEUTRON. Glasgow, D. W.; Foster, D. G. Jr. (Battelle-Northwest, Richland, Wash.). Phys. Rev., 157: 764-70(May 20, 1967).

The n-d total cross section was measured at 241 different energies to a precision of 1.0 to 5.7% and an energy resolution of 2.0 to 5.1% for $2.25 \leq E_n \leq 15.0$ MeV. The results support the correctness of present three-body calculations and exhibit no evidence for a Wigner cusp near the predicted threshold for dineutron production. In the absence of such a cusp, an experiment of this type furnishes very little information regarding the existence of the dineutron, or violations of charge independence. (auth)

31704 SOLAR NEUTRINOS FROM THE $^3He(p,e^+\nu)^4He$ REACTION. Werntz, Carl; Brennan, J. G. (Catholic Univ. of America, Washington, D. C. Naval Ordnance Lab., Silver Spring, Md.). Phys. Rev., 157: 759-63(May 20, 1967).

An upper limit to the cross section for the reaction $^3He(p,e^+\nu)^4He$ is calculated by comparing its matrix element with the matrix element of the $^3He(n,\gamma)^4He$ reaction, for which an experimental upper limit of 100 μb has been obtained. Expressing the cross section in the form $\sigma_\beta = (S/E_p)\exp(-2\pi\eta)$, where E_p is the center-of-momentum proton energy and $\eta = 2 \times 3\ Me^2/4\hbar^2 k_p$ with k_p the relative proton wave number, a value for the constant S of $S \cong 3.7 \times 10^{-20}$ keV b is obtained, as against the older value of 6.3×10^{-18} keV b. This result indicates that the $^3He(p,e^+\nu)^4He$ reaction is a negligible source of solar neutrinos compared to the ^8B decay. (auth)

31705 INVESTIGATION OF THE ENERGY EDGE OF NEUTRONS FROM THE REACTION $T(d,n)^4He$. Breunlich, W. H. Oesterr. Akad. Wiss. Math.-Naturwiss. Kl., Sitzungsber., Abt. II, 175: 1-15(1966). (In German).

The investigation of the neutron energy edge shows that in accelerators with a deuteron energy of some 100 keV a range of neutron energy from 1 to 1.5 MeV is available in which the half-value width of the neutron energy distribution can be smaller than 100 keV when very thin Ti-T targets are used. Since the form of the neutron energy distribution varies with the mean neutron energy, there are difficulties in the evaluation of experimental results by the statistical theory of nuclear reactions. These are not discussed. The best ratios are at deuteron energies of several MeV since a larger range of neutron energies is available and the energy edge of the neutron is further improved. This is due to the fact that the effects of the scattering and slowing down of the deuterons is lower. With gas targets, half-value width of the neutron energy distribution of approximately 20 to 30 keV can be obtained. The neutron yield is, however, much smaller since in Van de Graaff accelerators only ion currents of the order of magnitude of 100 μamp are attainable and the effective cross section for the D-T reaction at 2 MeV deuteron energy is only about 120 mb (opposed to 5 b at 120 keV). The relatively large energy edge of the neutron is very unfavorable since the possibilities of the theoretical evaluation of experimental data from reactions of the type (n, charged particle) are very sharply limited. (tr-auth)

31706 ELASTIC SCATTERING OF POLARIZED PROTONS BY HELIUM AT LOW ENERGIES. Ad'yasevich, B. P.; Antonenko, V. G.; Polunin, Yu. P.; Fomenko, D. E. Yadern. Fiz., 5: 933-6(May 1967). (In Russian).

The measurements of the left-right asymmetry in the elastic scattering of polarized protons by ^4He have covered the range of energy of values from 200 to 500 keV at the angle 110° in c.m.s. The experimental data are compared with the theoretical results obtained by means of the extrapolation of the phase shifts to the low energies at different values of the scattering parameters and the parameters of the $P_{\frac{3}{2}}$ and $P_{\frac{1}{2}}$ levels of the ^5Li nucleus. (auth)

31707 PROPAGATION OF NUCLEAR SPIN POLARIZATION IN QUIET AND FLOWING ^3He. Escher, G.; Turowski, P. (Technische Hochschule, Karlsruhe, Ger. Kernforschungszentrums, Karlsruhe, Ger.). Z. Angew. Phys., 21: 500-3(1966). (In German).

The polarization of the ^3He nuclear spin generated by optical pumping is propagated from the polarization cell to attached spaces largely free of loss, if the polarization cell and the attached spaces are kept under the influence of a uniform magnetic field of sufficient homogeneity. Employing the field of the earth for generating and carrying the polarization results in only relatively low degrees of polarization. This may be due to the fact that the weak inhomogeneities of the magnetic field present in the laboratory in this case present relatively high relative inhomogeneities. (auth)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 31606, 31736, 31737, 31743, 31777, 31829, 31834, 31836, 31838, 31846, 31852, and 31881.

31708 (CEA-R-3160) REALISATION D'UN ENSEMBLE D'ANALYSE BIPARAMETRIQUE. APPLICATION A L'ETUDE DE LA DESINTEGRATION DU NIVEAU DE 16,11 MeV DU ^{12}C. (Construction of a Biparametric Analysis System. Application to the Study of the Decay of the 16.11-MeV Level of ^{12}C). Engelhardt, Hans-Dieter (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1967. 66p. (In French). Dep.

Thesis. Submitted to Univ. of Grenoble, France.

A biparametric analysis system was assembled to measure $\alpha-\alpha$ spectra in coincidence (resolution $2\tau = 10$ ns). The correlations in energy and angle of the α particles emitted from the reaction $^{11}B(p,\alpha)$ were studied using 163-keV protons produced by a Van-de-Graaff accelerator. Evidence was obtained for the sequential decay of $^{12}C^*(16.11\ MeV)$ via the 0^+ and 2^+ states of ^8Be. Contributions from the $^8Be^*(4^+)$ level or from the simultaneous breakup of $^{12}C^*(16.11\ MeV)$ into three α particles cannot be excluded. (auth)

31709 (JINR-P1-3306) ZAKHVAT OTRITSATEL'NYKH π-MEZONOV YADRAMI UGLERODA I TETRANEITRON. (Negative Pion Capture by Carbon and Tetraneutron Nuclei). Batusov, Yu. A.; Bunyatov, S. A.; Sidorov, V. M.; Yarba, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 8p. (In Russian). Dep.

Negative pion capture by photoemulsion nuclei with the production of ^8Li and ^8B was investigated. One-prong events were analyzed in order to separate the reaction $\pi^- + {}^{12}C \rightarrow {}^8B + {}^4n$. The relative probability of the reaction R_1 with the tetraneutron production in the capture of mesons (π_c^-) by carbon nuclei is found to be smaller than 2.6.10. (auth)

31710 (RHEL/R-136, pp 52-88) PROTON INDUCED REACTIONS. (Rutherford High Energy Lab., Chilton (England)).

Some studies of the $^{24}Mg(p,d)^{23}Mg$ and $^{24}Mg(p,t)^{22}Mg$ reactions; neutron polarization from (p,n) reactions on D, ^6Li, and ^7Li using 30- and 50-MeV polarized protons; angular distributions for (p,n) reactions to analog states at 30 and 50 MeV; the excited states of ^6Be and ^7Be from $^6Li(p,n)$ and $^7Li(p,n)$ reactions; (p,d) reactions on Sn isotopes at 30 MeV; pick-up reactions; $T = \frac{3}{2}$ analog levels in 2s1d-shell nuclei; the mass and energy levels of ^{38}Ca from the reaction $^{40}Ca(p,t)^{38}Ca$; and the excitation of isomeric states in ^{38}K are summarized. (D.C.W.)

31711 CALCULATION OF ^{16}O BINDING ENERGY. McCarthy, R. J.; Koehler, H. S. (Rice Univ., Houston, Tex.). Contract AT(40-1)-1316. Nucl. Phys., A99: 65-82(1967). (ORO-1316-29).

The binding energy of ^{16}O was calculated for the Hamada-Johnston and Brueckner-Gammel-Thaler potentials using an approximation scheme similar to the reference spectrum method. A first-order approximation to the K-matrix is obtained by neglecting both the Pauli principle and the potential energy in intermediate states. The only correction term calculated is that due to the Pauli principle but the method can be extended to include a more general energy spectrum. Harmonic oscillator wave functions are used to describe the single particle orbitals and a self-consistent calculation of the K-matrix elements is made for several values of the oscillator parameter. The correct parameter is chosen as the one which minimizes the total energy. First-order binding energies of 5.20 and 7.70 MeV/nucleon are obtained for the Hamada-Johnston and Brueckner-Gammel-Thaler potentials, respectively. The Pauli correction reduces the binding obtained to 2.70 and 4.27 MeV. The results are not considered final. Specifically, three-body interactions have to be calculated, and the effect of higher-order insertions in hole lines should be investigated. (auth)

31712 SPECTROSCOPIC FACTORS FOR THE (p,2p) REACTION. Jain, B. K.; Jackson, Daphne F. (Univ. of Surrey, London). Nucl. Phys., A99: 113-30(1967).

The data on the (p,2p) reaction on the 1p shell nuclei at incident proton energies of 155 to 185 MeV are analyzed in terms of spec-

troscopic factors, and comparison is made with theoretical predictions from the work of Cohen and Kurath. (auth)

31713 $^{9}Be(d,n)^{10}B$ REACTION AND THE EXISTENCE OF THE 2.86 MeV STATE IN ^{10}B. Glasgow, D. W.; Foster, D. G. Jr. (Battelle-Northwest, Richland, Wash.). Nucl. Phys., A99: 170-6 (1967).

A high-precision study was made of the neutron energy spectrum from the $^{9}Be(d,n)^{10}B$ reaction with a very low background, good-resolution, pulsed-beam time-of-flight system. The study provided no evidence for the existence of an excited state in ^{10}B at 2.86 MeV for bombarding energies of 1.7 and 1.8 MeV. The results are in agreement with applications of the individual-particle model with intermediate coupling to the nuclear 1p-shell. (auth)

31714 EMISSION OF FAST ^{3}He IN NUCLEAR SPALLATION. Takibaev, Zh. S.; Toktarov, K. A.; Zancheva, F. N. Vestn. Akad. Nauk Kaz. SSR, No. 12, 21-5(Dec. 1966). (In Russian).

Previous calculations of W(R), Σ_{H^3}, q_{H^3} for the ^{3}H nuclei indicated the importance of fast doubly charged particle emission in nuclear spallation processes. An approximate analysis is made of the appearance of fragments of ^{3}He and ^{4}He type. The W(R), Σ_{He^3}, and q_{He^3} for ^{3}He were found on the basis of the fluctuation mechanism producing such fragments. The tabulated data indicate the W and Σ as functions of the fluctuation type for R = 4.207 × 10^{-14} cm. An attempt to determine $\Sigma_{\pi_{He}}$ in an energy range of 7.8 to 17.5 GeV for the incoming π meson and 9 to 19.5 GeV for the incoming proton showed that for such energies $\Sigma_{\pi_{He}} = 0$ with the precision of the order of the fifth decimal. (R.V.J.)

31715 QUASI-FREE SCATTERING OF ELECTRONS AND NUCLEAR SHELL STRUCTURE. Devanathan, V. (Univ. of Virginia, Charlottesville). Ann. Phys. (N.Y.), 43: 74-90 (June 2, 1967).

Quasi-free scattering of electrons on nuclei resulting in the emission of protons is investigated using the effective Hamiltonian of McVoy and Van Hove for the electron-nucleon interaction. The coincidence cross section for (e,e'p) reaction is deduced in the impulse approximation. The shell structure of the nucleus can directly be studied since the energy of the outgoing proton depends upon the shell from which it is ejected and its binding energy. The angular distribution of the outgoing proton reveals interesting features and numerical results are presented for ^{12}C, ^{16}O, and ^{28}Si. (auth)

31716 STUDY OF THE PERTURBED ANGULAR DISTRIBUTION IN ^{19}F IN FERROMAGNETIC LATTICES. Braunsfurth, J. (Univ., Hamburg); Morgenstern, J.; Schmidt, H.; Koerner, H. J. Z. Phys., 202: 321-39(1967). (In German).

The perturbation of the 197-keV transition angular distribution in ^{19}F was investigated by time-dependent spin-rotation measurements following excitation with a pulsed beam. The recoil implantation technique was used to determine the internal magnetic fields for ^{19}F in Fe, Co and Ni lattices. The temperature and field dependence of the effective fields were studied. Strong satellite fields due to lattice perturbations were detected. The half life and the gyromagnetic ratio of the 197-keV, $5/2^+$ state in ^{19}F were redetermined to be 80.2 ± 0.5 nsec and +1.436 ± 0.007. (auth)

31717 SPIN DETERMINATION OF GROUND STATE OF ^{10}B THROUGH MOTT SCATTERING. Bethge, K.; Guenther, G.; Schubert, K. R.; Speth, E. (Univ., Heidelberg). Z. Phys., 202: 70-3(1967). (In German).

From Mott scattering of ^{10}B on ^{10}B, the ground-state spin of ^{10}B is directly determined to be 3 in agreement with the theoretical prediction of the intermediate-coupling model. (auth)

31718 MONOPOLE EXCITATION OF DEFORMED 0^+ STATES IN ^{16}O AND ^{40}Ca. Boeker, E. (Vrije Univ., Amsterdam). Phys. Lett., 24B: 616-18(June 12, 1967).

The form factors for inelastic electron scattering to the first excited 0^+ levels in ^{16}O and ^{40}Ca are calculated using the Brown and Green model. It is shown that the form factors are strongly dependent on the deformations of the states. The monopole matrix element of the ^{40}Ca $0^+ \rightarrow 0^+$ transitions becomes 2.46 fm^2 (exp. 2.5 fm^2). (auth)

31719 INTRINSIC DEFORMED STATES IN ^{16}O. Abgrall, Y.; Caurier, E.; Monsonego, G. (Centre de Recherches Nucleaires, Strasbourg). Phys. Lett., 24B: 609-12(June 12, 1967).

A Hartree-Fock calculation of axially symmetric and asymmetric n-particle, n-hole intrinsic states ($0 \leq n \leq 8$) is outlined. The levels, recently seen in the $\alpha + {}^{12}C \rightarrow {}^{8}Be + {}^{8}Be$ reaction, are identified as members of a rotational band generated by an axially symmetric 8p – 8h state. (auth)

31720 MEASUREMENT OF THE $^{6}Li(n,ABSORPTION)$ AND $^{10}B(n,ABSORPTION)$ CROSS SECTIONS BY THE SHELL TRANSMISSION METHOD. Cox, S. A.; Pontet, F. R. (Atomic Weapons Research Establishment, Aldermaston, Eng.). J. Nucl. Energy, 21: 271-83(Mar. 1967).

The spherical shell transmission method was used to measure the total neutron absorption cross sections for ^{10}B from 10.7 to 247 keV and for ^{6}Li from 10.7 to 102 keV. For ^{6}Li the absorption cross section could be equated directly to the (n, α) cross section. In the case of ^{10}B, the absorption cross section may contain a weak component due to the (n, t) reaction, in addition to the (n, α) reaction. The ^{10}B(n, α) measurements near 10 keV are in good agreement with a $1/\nu$ extrapolation from the thermal cross section. The ^{6}Li(n, α) results near 10 keV are ~30% higher than a $1/\nu$ extrapolation from the thermal cross section and are in agreement with some earlier work, but are in disagreement with recent measurements of Bergman and Shapiro and of Schwarz, Stromberg and Bergstrom, both of which are consistent with a $1/\nu$ extrapolation. (UK)

31721 STUDY OF THE DECAY OF $^{12}C^*$ INTO 3α BY THE REACTION $^{10}B(d,\alpha\alpha)\alpha$ AT ABOUT 1 MeV. Longequeue, Jean-Pierre; Cavaignac, Jean-Francois; Giorni, Alain; Bouchez, Robert (Univ., Grenoble, France. CEN, Grenoble, France). Compt. Rend., Ser. A and B, 264: 1032-5(Apr. 3, 1967). (In French).

The decay into three α particles of the level of ^{12}C obtained by the reaction $^{10}B(d,\alpha)$ at 600, 950, and 1450 keV shows the existence of levels of ^{8}Be of 0^+, 2^+ at 2.9 MeV, 4^+ at 11.4 MeV, and 2^+ at 16.6 and 16.9 MeV. The measured width (≈4 MeV) for the 4^+ level is less than the admitted width (≈7 MeV). (tr-auth)

31722 SPINS AND PARITIES OF 9485, 9490, 9613, AND 9670-keV LEVELS OF ^{15}O. Lambert, M.; Durand, M. (Institut d'Etudes Nucleaires, Alger, Algiers). J. Phys. (Paris), 28: 349-62(Mar.-Apr. 1967). (In French).

The differential cross sections for elastic scattering of protons from ^{14}N were measured to an accuracy of 6% for proton energies from 1.7 to 3.0 MeV at center-of-mass scattering angles of 74° 34′, 113° 09′, 156° 54′, and 166° 03′ with approximately 3-keV energy resolution in a gas scattering chamber with differential pumping. Theoretical curves calculated from a three-level formula were fitted to the data between 2 and 3 MeV. Four resonances, all previously observed, were necessary to fit the data. (auth)

31723 THERMAL NEUTRON ABSORPTION CROSS SECTION OF BORON. Debus, G. H.; De Bievre, P. J. (EURATOM, Geel, Belg.). J. Nucl. Energy, 21: 373(Apr. 1967).

New values are given for the cross section of ^{10}B which are based on a more accurate isotopic analysis of the materials used in an earlier determination. (UK)

31724 ISOBARIC-SPIN MIXING IN ^{8}Be STATES. Marion, J. B.; Nettles, P. H.; Cocke, C. L.; Stephenson, G. J. Jr. (California Inst. of Tech., Pasadena). Phys. Rev., 157: 847-53(May 20, 1967).

The $^{7}Li(^{3}He,d)^{8}Be$ reaction was studied using a magnetic spectrometer in order to obtain precise values for the widths of the isobaric-spin-mixed states at 16.6 and 16.9 MeV in ^{8}Be. The results are $\Gamma(16.6) = 113 \pm 3$ keV and $\Gamma(16.9) = 77 \pm 3$ keV. These values specify the isobaric-spin amplitudes of the wave functions for these states and show that, while the mixing is not complete, it is quite substantial. This mixing gives rise to interference effects that are manifest in such reactions as $^{10}B(d,\alpha)^{8}Be$. It is pointed out that attempts to infer a cross-section ratio $\sigma(16.6)/\sigma(16.9)$ from such a reaction by taking the areas under the peaks in an experimental energy spectrum can be seriously in error if the interference effects are neglected. The excitation energies for the states were found to be 16.627 ± 0.005 and 16.901 ± 0.005 MeV. (auth)

31725 STUDY OF THE REACTIONS $^{18}O(p,n)^{18}F$, $^{18}O(p,p'\gamma)^{18}O$ AND $^{18}O(p,\alpha_{1,2}\gamma)^{15}N$ FROM E_p = 2500 TO 3000 keV. Prosser, F. W. Jr.; Din, G. U.; Tolbert, D. D. (Univ. of Kansas, Lawrence). Phys. Rev., 157: 779-86(May 20, 1967). (COO-1120-50).

The reactions $^{18}O(p,n)^{18}F$, $^{18}O(p,p'\gamma)^{18}O(p,\alpha_{1,2}\gamma)^{15}N$ were investigated in the energy range E_p = 2.5 to 3.0 MeV by simultaneous observation of the neutrons, 1.98-MeV γ rays, and 5.30-MeV γ rays. Angular distributions of the 1.98-MeV γ rays were measured at the five prominent inelastic scattering resonances. The threshold for neutron production was found to be 2577 ± 3 keV. The following resonances in the three decay channels were identified: (neutron) 2645, 2696, 2722, 2769, and 2926 keV; (alpha) 2645, 2769, and 2926 keV; and (proton) 2633, 2705, 2732, 2769, and 2926 keV. Spins and parities were assigned to several of these resonances: 2633, $5/2^{(+)}$; 2645, $(3/2)$; 2705, $3/2^{(+)}$; 2732, $5/2^{(+)}$ $(3/2)$; and 2769, $5/2^{(+)}$. All parity assignments, as well as the spin assignment of the 2645-keV resonance, are based on physical arguments. Comparison of the properties of the elastic scattering resonance at 849 keV and the resonances at 2633 (and 2732) and 2705 keV with those of the known and theoretically predicted

states in ^{15}O indicates that they are isobaric-spin analog states; however, isobaric-spin impurities are present. (auth)

31726 MECHANISM OF NUCLEON TRANSFER REACTIONS INDUCED BY 148-MeV ^{14}N IONS. Birnbaum, J.; Overley, J. C.; Bromley, D. A. (Yale Univ., New Haven). Phys. Rev., 157: 787-802(May 20, 1967).

Neutron and proton transfer reactions were studied in the ^{12}C + ^{14}N system using a 148-MeV ^{14}N beam and an isotopic identification system capable of resolving isolated residual states. Highly selective population of states having a simple one-nucleon configuration based on the ^{14}N ground state was observed in the $^{12}C(^{14}N,^{15}O)^{11}B$ and $^{12}C(^{14}N,^{13}N)^{11}C$ analog reactions. The ratio of cross sections for these reactions is well reproduced on the assumption of charge symmetry. Calculations based on the Boyarkina and on the Kurath wave functions are in agreement with the observed relative population of the ground and first excited states of the A = 11 mirror pair. None of the transfer angular distributions show diffraction oscillations, contrary to the predictions of the Frahn and Venter model. Both the Dar and the Dodd and Greider models can reproduce experimental results; however, the evidence now available on heavy-ion transfer reactions favors the finite range potential and recoil mechanism of the latter model. (auth)

31727 $^{14}N(n,t)$ AND $^{14}N(n,d)$ ANGULAR DISTRIBUTIONS AT 14.7 MeV. Lindsay, Richard H.; Veit, J. J. (Western Washington State Coll., Bellingham). Phys. Rev., 157: 933-8(May 20, 1967).

A triple-coincidence counter telescope consisting of two proportional dE counters and a solid-state E detector was used to study the angular distributions of tritons and deuterons for the ground-state transitions of ^{14}N induced by 14.7-MeV neutrons. The relative triton-to-deuteron peak yield was found to be about 0.3. The (n,t) angular distribution is compared with pickup theory and with two other deuteron-transfer interactions between the ground states of ^{14}N and ^{12}C: the $^{14}N(\alpha,^6Li)$ and $^{14}N(d,\alpha)$ reactions. In these reactions the orbital angular momentum of the picked-up deuteron is principally L = 2, with a smaller contribution from L = 0 pickup suggested by the data. In addition, the $^{14}N(n,d)$ angular distribution is compared with the Gaussian-cutoff pickup theory, and with the $^{14}(p,d)$ reaction to the ground state of the mirror nucleus ^{13}N. The angular distributions, absolute magnitudes, and reduced widths of the two reactions are nearly identical, as expected. Cluster-model interpretations of the ^{14}N data are discussed. (auth)

31728 EFFECT OF THE SPIN-ORBIT FORCE ON MUON-CAPTURE MATRIX ELEMENTS FOR CLOSED-SHELL NUCLEI. Walker, G. E. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 157: 854-9(May 20, 1967).

The vector, axial-vector, and pseudoscalar matrix elements for muon capture in closed-shell nuclei are studied in the case where a single-particle spin-orbit potential is included in the nuclear shell-model Hamiltonian. Because of sum rules arising from the rotational properties of the operators and wave functions involved, and in addition, because of the smallness of the ratio of the nuclear spin-orbit energy splitting to the emitted neutrino energy, it is found that the effect of the spin-orbit force is negligible. More precisely, if one considers a multipole expansion of the plane-wave neutrino wave function appearing in each of the matrix elements, it is found that the individual multipolar matrix elements are altered by less than 1% by the addition of the spin-orbit potential to the nuclear Hamiltonian. Therefore, to the same degree of accuracy, it is concluded that the magnitude of each of the vector, axial-vector, and pseudoscalar matrix elements remains unchanged. Finally, based on calculations reported here and elsewhere, it is conjectured that inaccuracies in the $(1p)^{-1}2s$ and $(1p)^{-1}1d$ wave functions of ^{16}N are not the prime source of the disagreement between the observed muon-capture rate in ^{16}O and that calculated using nuclear wave functions derived from a shell model plus residual interaction. Other mechanisms, are suggested which, if properly taken into account, may allow one to obtain better agreement with the experimental muon-capture rate in ^{16}O. (auth)

31729 PROTON-CAPTURE GAMMA RAYS FROM ^9Be, ^{12}C, ^{24}Mg, AND ^{40}Ca IN THE GIANT-RESONANCE REGION. Feldman, L. (Columbia Univ., New York); Baliga, B. B.; Nessin, M. Phys. Rev., 157: 921-8(May 20, 1967).

The 90° yield for gamma rays from ^9Be, ^{12}C, ^{24}Mg, and ^{40}Ca was determined for (p,γ) reactions using 10.4- to 14.5-MeV protons from the Columbia University variable energy cyclotron. For $^{11}B(p,\gamma)^{12}C$ the yields to both the first excited state and the ground state of the residual nucleus are presented. In the case of ^{39}K $(p,\gamma)^{40}Ca$, only the ground-state yield was determined. Because the ground-state yields are very small, only the yield due to transitions to the first excited state for the $^7Li(p,\gamma)^8Be$ reaction and the combined first excited and ground-state yields for the $^{23}Na(p,\gamma)^{24}Mg$ reaction are reported. In the region investigated, the yield curves exhibit a considerable amount of fine structure in all cases except $^7Li(p,\gamma)^8Be$. Fine-structure peaks were observed for the following excitation energies: 21.9, 22.4, 22.7, 23.0, 23.3, 24.1, 24.7, and 25.4 MeV for $^{23}Na(p,\gamma_0+\gamma_1)^{24}Mg$; at 18.8, 19.2, 19.5, 20.0, 21.0, and 21.7 MeV for $^{39}K(p,\gamma_0)^{40}Ca$; at 25.5, 26.9, 28.0, and 28.45 MeV for $^{11}B(p,\gamma_1)^{12}C$; and at 25.5, 27.45, 28.0, and 28.9 MeV for $^{11}B(p,\gamma_0)^{12}C$. A comparison with other experimental results shows that some of these peaks have not been previously observed. (auth)

31730 EXCITED LEVELS IN ^{20}F AT 1.82 AND 1.84 MeV. Quin, P. A.; Rollefson, A. A.; Bissinger, G. A.; Browne, C. P.; Chagnon, P. R. (Univ. of Notre Dame, Ind.). Phys. Rev., 157: 991-4(May 20, 1967).

Examination of the γ-ray spectrum from $^{18}O(^3He,p\gamma)^{20}F$ in the region near 1.85-MeV excitation has indicated the existence of a new level in addition to the one previously reported. With a magnetic spectrograph, this doublet structure was confirmed, and the excitation energies of the two levels were measured as 1824.4 ± 2.1 and 1843.0 ± 2.2 keV. The separation is 18.6 ± 0.7 keV. Directional correlations of γ rays from these levels were studied in an axially symmetric arrangement. Based on these correlations, the spins of both levels are restricted to the values 1, 2, or 3; a probable assignment of spin 2 or 3 is made for the 1.84-MeV level. Branching ratios and multipole mixtures are reported. (auth)

31731 ON THE TOTAL MUON CAPTURE RATE IN ^6Li AND NUCLEAR CLUSTER STRUCTURE. Palgi, L. (Inst. of Physics and Astronomy, Tartu). Izv. Akad. Nauk Est. SSR, Fiz. Mat., 16: No. 1, 122-3(1967).

The total muon capture rates for ^6Li and ^7Li were measured by Eckhause et al., to be $A(^6Li) = 5700 \pm 1200\ sec^{-1}$ and $A(^7Li) = 1300 \pm 900\ sec^{-1}$. The theoretical investigation of these quantities was performed by Lodder and Jonker in two ways: by means of the closure approximation and by making use of the method of Foldy and Walecka. The total capture rate for ^7Li proves comparable with experiment, but the total capture rate for ^6Li (<4000 sec^{-1}) turns out to be too low. The total capture rate for ^6Li is considered, assuming nuclear clustering. (auth)

31732 π^- INVESTIGATION OF THE MECHANISM OF RADIATIVE π^--CAPTURE BY COMPLEX NUCLEI. Petrukhin, V. I.; Pogosov, V. S.; Prokoshkin, Yu. D. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 1045-53(May 1967). (In Russian).

The experimental evidence is presented that the neutron escape in the direction opposite to that of the γ-quantum occurs at the radiative capture of π^--mesons by the Li nuclei. All the precious properties of the observed process are in accordance with the assumption about the one-nucleon mechanism of the radiative π^--capture by nuclei. (auth)

31733 PROBING NUCLEAR STRUCTURE WITH 1-GeV PROTONS. Palevsky, Harry (Brookhaven National Lab., Upton, N. Y.). Nucleonics, 25: No. 5, 72-6; 82(May 1967).

A high-resolution magnetic spectrometer was used with the 1-GeV proton beam of the Brookhaven Cosmotron to study individual nucleons within the nucleus and to study the correlation of their positions. Experimental spectra are presented for proton elastic and inelastic scattering on ^4He, ^{12}C, and ^{16}O. Evidence was obtained for the tendency of nucleons to pair off in a nucleus. In particular, it was concluded that quasi-free n–p pairs, or deuterons, exist inside the ^{12}C nucleus. (S.F.L.)

Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 30753, 31692, 31710, 31714, 31715, 31718, 31729, 31730, 31773, 31780, 31781, 31821, 31828, 31829, 31834, 31836, 31838, 31843, 31846, and 31865.

31734 (ANS-SD-3, Session 1, Paper 3) ENERGY SPECTRA FROM INELASTIC NUCLEAR REACTIONS AT ENERGIES BELOW 450 MeV. Bertini, Hugo W. (Oak Ridge National Lab., Tenn.). 16p.

A brief description is presented of a nuclear calculation which provides information on particle reactions with nuclei at energies up to 450 MeV. The results of such a calculation are then compared with experimental results in order to evaluate the attenuation of high-energy radiation in thick shields. (B.G.D.)

31735 (ANS-SD-3, Session 2, Paper 5) SHIELDING ATTENUATION OF NEUTRONS FROM 80-MeV α-PARTICLE BOMBARDMENT OF ELEMENTAL TANTALUM. Wadman, William W. (California Univ., Berkeley. Lawrence Radiation Lab.). 26p. (UCRL-16359).

The angular distribution, spectra, total yield, and attenuation of neutrons from the bombardment of a thick elemental-tantalum target were simultaneously studied. Data were obtained with threshold-energy detectors and thermal-neutron detectors placed at several angles with respect to the target. Thermal-neutron detectors, spaced at 6-inch intervals throughout the shielding, were used to determine the relaxation length in the materials at 0, 75, and 90° from the geometrical center of the target. The neutron spectra have a peak at about 4 MeV and a slope that falls off at about 1/energy out of the production cut-off point for the forward neutrons, and a first and second preneutron-production α-particle scatter factor applied to the evaporation spectra of 75 and 90°. The 75 and 90° neutron energy cutoff is slightly less than that from the 0° neutron spectrum, and is only 2% of the 0° intensity beyond 15 MeV. The total fast-neutron yield, calculated on the basis of the $^{58}Ni(n,p)^{58}Co$ reaction, is 3.0×10^{11} neutrons per sec per μA of α particles. The attenuation profiles for the 0, 75, and 90° angles from the target were established. The 0° relaxation lengths in iron followed by concrete are ≈147.5 and 48 g/cm^2, respectively; apparently the iron value changes continuously. The effective neutron energy represented by the relaxation length in concrete is 45 MeV per neutron. At 75° the relaxation lengths in iron followed by concrete are ≈92.5 g/cm^2 and 32.1 g/cm^2, respectively. The effective neutron energy represented by the relaxation length in concrete is about 20 MeV per neutron. In concrete only the 90° relaxation length is 32.1 g/cm^2; the effective neutron energy is 20 MeV per neutron. (auth)

31736 (NAA-SR-11980(Vol.4)) COMPILATION, EVALUATION, AND REDUCTION OF NEUTRON DIFFERENTIAL SCATTERING DATA. Campbell, R. W.; Davis, S. K.; Alter, H.; Dunford, C. L., Berland, R. F. (Atomics International, Canoga Park, Calif.). Apr. 3, 1967. Contract AT(04-3)-701. 288p. Dep. CFSTI.

A compilation is given of the angular distributions of elastically scattered neutrons, based on available experimental data, for isotopes in the mass range $2 \leq A \leq 244$. These data were analyzed and reduced into a form convenient for use in digital computer calculations. The elastic differential scattering data are represented by expansions in a finite series of Legendre polynomials with energy-dependent coefficients in the center-of-mass coordinate system. A listing of the Legendre coefficients for all angular distributions, as well as plots of selected data, are included. The primary source of experimental data was report BNL-400, second edition. (S.F.L.)

31737 (RHEL/R-136, pp 28-51) PROTON SCATTERING. (Rutherford High Energy Lab., Chilton (England)).

Differential cross sections and/or polarizations were measured for the elastic and/or inelastic scattering of 30- and/or 50-MeV protons by ^{9}Be, ^{40}Ca, ^{12}C, ^{52}Cr, ^{59}Co, D, H, ^{54}Fe, ^{56}Fe, ^{208}Pb, ^{6}Li, ^{7}Li, ^{24}Mg, ^{58}Ni, ^{60}Ni, ^{64}Ni, ^{112}Sn, ^{114}Sn, ^{120}Sn, ^{124}Sn, ^{48}Ti, ^{50}Ti, ^{51}V, ^{64}Zn, ^{66}Zn, ^{68}Zn, and ^{70}Zn. Several optical-model analyses were performed. (D.C.W.)

31738 (TID-23854) A STUDY OF ^{46}Ti, ^{48}Ti, ^{50}Cr, AND ^{54}Fe USING TRIPLE CORRELATIONS. Church, David J. (Columbia Univ., New York). 1967. 107p. Dep. CFSTI.

Thesis.

A number of excited states in the nuclei ^{46}Ti, ^{48}Ti, ^{50}Cr and ^{54}Fe were studied by means of triple angular correlation measurements. The excited states were produced by proton inelastic scattering. Coincident gamma-ray angular correlation measurements were made on the cascade from the state being studied, through the first excited state. The populations of the magnetic substates of the initial state in the cascade were treated as unknowns in the analysis of the experimental data. The 2.01-, 2.61-, and 2.96-MeV states in ^{46}Ti were studied at an incident proton energy of 5.00 MeV. The experimental results for the 2.01-MeV state were consistent with a previous J = 4 assignment. The 2.61-MeV state was unambiguously assigned J = 0. The 2.96-MeV state has either J = 2 or J = 3, with a mixing ratio for the decay to the 0.89-MeV state of $\delta = -1.07 \pm 0.15$ for J = 2, or $\delta = +0.26 \pm 0.05$ for J = 3. The 3.00-MeV state in ^{48}Ti was studied at an incident proton energy of 4.75 MeV. The experimental results permitted an unambiguous spin assignment of J = 0 for the 3.00-MeV state. The 1.90-, 2.94-, and 3.18-MeV states in ^{50}Cr were studied at an incident proton energy of 5.56 MeV. The experimental results for the 1.90-MeV state were consistent with a previous J = 4 assignment, and definitely exclude a recent J = 0 assignment to this state. The spins of the 2.94- and 3.18-MeV states were determined to be either J = 2 or J = 3. Both of these states were recently assigned J = 2. The mixing ratios determined by the present work for the J = 2 assignment are as follows. The mixing ratio for the transition from the 2.94-MeV state to the 0.79-MeV state is $\delta = -0.17 \pm 0.05$. The mixing ratio for the transition from the 3.18-MeV state is $\delta = +0.20 \pm 0.05$. The 2.56-MeV state in ^{54}Fe was studied at an incident proton energy of 5.15 MeV. The experimental results permitted an unambiguous spin assignment of J = 0 for the 2.56-MeV state. (auth)

31739 (ANL-Trans-476) RADIATION ASYMMETRY AND NMR OF β-ACTIVE NUCLEI, FORMED DURING THE CAPTURE OF POLARIZED THERMAL NEUTRONS. Gul'ko, A. D.; Trostin, S. S.; Khudoklin, A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Preprint 479. 57p. Dep. CFSTI. JCL $5.60 fs, $1.91 mf.

The results of an investigation of the irradiation asymmetry and of NMR of polarized β-active nuclei are given. Polarized nuclei are produced when irradiating the unpolarized target by polarized thermal neutrons. The device makes it possible to perform the investigations with different temperatures of the target down to liquid helium temperature. Physical basis of the phenomenon under investigation is studied in detail as well as the connection of the experimentally observed shape of the NMR line with the natural one defined by the local field. The following investigations were performed using the device: as a control experiment the neutron magnetic moment was measured; for the nuclei ^{8}Li, ^{20}F, ^{110}Ag, ^{108}Ag, and ^{66}Cu the spins of excited states produced by the capture of thermal neutrons were determined, and values of polarization of the main states of these nuclei are given; the magnetic moments of the main states of the nuclei ^{8}Li and ^{20}F were measured, and from the shape of the NMR line the local fields in these nuclei in the crystals ^{7}LiF and CaF_2 were determined; the increase of the asymmetry of irradiation of ^{20}F nuclei and the change of the shape of the NMR curve was observed in the monocrystal CaF_2 by the temperature decrease of a sample up to helium; and it was shown that the systems of polarized β-active nuclei ^{108}Ag and ^{110}Ag in the crystalline samples of AgCl used consisted of two subsystems — one with the more time of relaxation and the other with the small one. The relaxation mechanism of these nuclei is discussed. (auth)

31740 A STUDY OF THE Ca(p,n)Sc REACTIONS. I. ENERGY LEVELS IN SCANDIUM ISOTOPES. McMurray, W. R.; Peisach, M.; Pretorius, R.; Van der Merwe, P.; Van Heerden, I. J. (Southern Universities Nuclear Inst., Faure, South Africa). Nucl. Phys., A99: 6-16(1967).

Time-of-flight measurements were made on the neutrons emitted from enriched targets of ^{42}Ca, ^{44}Ca, and ^{48}Ca bombarded by 4.0 to 5.5 MeV protons. Two additional levels were found in ^{43}Sc at 1347 ± 10 and 1424 ± 10 keV in agreement with recent work on the $^{40}Ca(\alpha,p)$ reaction; in ^{48}Sc, knowledge of the level structure was extended up to 4169 keV with the observation of 34 additional levels; and the measurements for the low-lying states in ^{44}Sc agree with previous work. The measured (p,n_0) Q-values for ^{43}Ca, ^{44}Ca, and ^{48}Ca are −2998 ± 10, −4447 ± 10 and −534 ± 15 keV, respectively. (auth)

31741 A STUDY OF THE Ca(p,n)Sc REACTIONS. II. FLUCTUATION ANALYSIS OF THE REACTION $^{48}Ca(p,n)^{48}Sc$. McMurray, W. R.; Peisach, M.; Pretorius, R.; Van der Merwe, P.; Van Heerden, I. J. (Southern Universities Nuclear Inst., Faure, South Africa). Nucl. Phys., A99: 17-27(1967).

The $^{48}Ca(p,n)^{48}Sc$ reactions to the first 11 excited states in ^{48}Sc were studied as a function of angle and proton energy from 4.03 to 5.63 MeV. Absolute cross sections (±25%) have been obtained using a calibrated, time-of-flight detection system. The cross sections are observed to have random fluctuations in accordance with the Ericson fluctuation theory. There is no indication of any direct reaction contributions to the cross sections. The average angular distributions are symmetric about 90°. The coherence energy Γ is observed to be ≦9 keV at 15 MeV excitation in ^{49}Sc. Autocorrelation analysis of the cross sections for exciting the third to 11th excited states of ^{48}Sc leads to probable spins of (3,4), (1,2), (1,2), 2, (1,2), 1, (2,3), 2 and 0, respectively. (auth)

31742 ELECTRON-CAPTURE TO POSITON-EMISSION RATIO IN THE DECAY OF ^{22}Na. Leutz, H.; Wenninger, H. (Univ., Heidelberg). Nucl. Phys., A99: 55-64(1967).

The electron-capture to positon-emission ratio of ^{22}Na was measured as $e/\beta^+ = 0.1048 \pm 0.0007$. This ratio was also calculated using the corresponding transition probabilities; $(e/\beta^+)_{calc} = 0.1138 \pm 0.0025$ (omitting the correction for orbital electron exchange) and 0.100 ± 0.006 (including electron exchange). Comparison of the measured and calculated branching ratios yields $b = (-2.4 \pm 0.9) \times 10^{-2} m_0c^2$ (omitting electron exchange) and $(1.5 \pm 3.7) \times 10^{-2} m_0c^2$ (including electron exchange) for the Fierz interference term. Assuming zero Fierz interference, as indicated by many other measurements, the results yield strong evidence for orbital electron exchange effects. (auth)

31743 INFLUENCE OF DIRECT INELASTIC SCATTERING ON (n,2n) CROSS SECTIONS. Csikai, J. (Inst. of Nuclear Research, Debrecen); Petoe, G. Acta Phys. Acad. Sci. Hung., 23: 87-94(1967).

The (n,2n) cross sections were measured for the nuclei ^{14}N, ^{19}F, ^{48}Ca, ^{45}Sc, ^{55}Mn, ^{58}Ni, ^{65}Cu, ^{64}Zn, ^{66}Zn, ^{82}Se, ^{85}Rb, ^{87}Rb, ^{89}Y, ^{90}Zr, ^{92}Mo, ^{112}Sn, and ^{144}Sm at an excess energy of 3 MeV above threshold. In addition, the (n,2n) cross sections for the nuclei ^{64}Zn, ^{70}Zn, ^{69}Ga, ^{71}Ga, ^{75}As, ^{100}Mo, and ^{204}Pb as well as the cross section of the process ^{204}Pb(n,n')^{204m}Pb were determined at 14.7 MeV bombarding neutron energy. At 3 MeV excess energy a strong N−Z dependence was found in the (n,2n) cross sections, valid for a broad region of neutron numbers which can be accounted for by the influence of direct inelastic scattering leading to low-lying levels of the target nucleus. An empirical formula is given for calculating (n,2n) cross sections. (auth)

31744 LIFETIME MEASUREMENTS IN ^{30}Si. Lieb, K. P.; Grawe, H.; Roepke, H. (Univ., Freiburg i. B.). Nucl. Phys., A98: 145-53(1967).

The Doppler shift attenuation method was used to measure the lifetimes of the $J^\pi = 2^+$ 2.23-MeV and 3.50-MeV states in ^{30}Si. The states were produced in the reaction ^{27}Al(α,pγ). Their mean lifetimes were found to be $\tau(2.23) = 0.26 \pm 0.06$ ps and $\tau(3.50) = 0.086 \pm 0.020$ ps, respectively. Fairly good agreement with the predictions of the weak-coupling uniform model was obtained. (auth)

31745 MEASUREMENT OF THE NUCLEAR RADIUS DIFFERENCE OF ^{46}Ti, ^{48}Ti, AND ^{50}Ti BY ELASTIC ELECTRON SCATTERING. Theissen, Horst (Technische Hochschule, Darmstadt, Ger.). Z. Phys., 202: 190-213(1967). (In German).

Ratios of differential cross sections for elastic electron scattering from ^{46}Ti, ^{48}Ti and ^{50}Ti were measured at 29 and 58 MeV. A partial-wave analysis, carried out for static Fermi-type nuclear charge distributions, yields differences of the rms radii R_m of $R_m^{48} - R_m^{46} = (-0.00_5 \pm 0.02_7)$ fm and $R_m^{50} - R_m^{46} = (0.00_3 \pm 0.02_1)$ fm, if the skin thickness parameter z of the charge density is assumed to be constant. If allowance is made for a change in z of $\Delta z/z = \pm 5\%$ and $\pm 10\%$, then the errors increase by $\pm 0.01_3$ fm and $\pm 0.02_8$ fm, respectively. This indicates a relatively small change in nuclear rms radii below the magic neutron number N = 28. (auth)

31746 MASS SPECTROMETRIC DETECTION OF $\beta\beta$-DECAY PRODUCTS. Kirsten, T. (Max-Planck-Institut fuer Kernphysik, Heidelberg. State Univ. of New York, Stony Brook); Gentner, W.; Schaeffer, O. A. Z. Phys., 202: 273-92(1967). (In German).

The principles and methods of mass-spectrometric detection of $\beta\beta$-decay products and the theoretical purposes for such studies are discussed in detail. The results of new measurements on two tellurides, one native tellurium sample, and one selenide are also reported. Concerning the decay ^{130}Te $\xrightarrow{\beta^-\beta^-}$ ^{130}Xe, it was found that ^{130}Xe in a native tellurium sample amounts to 67% of the total xenon with an absence of any other anomaly, which is an important improvement over previous measurements. For the first time, the decay ^{82}Se $\xrightarrow{\beta^-\beta^-}$ ^{82}Kr was studied by mass spectrometry. A ^{82}Kr excess was positively found in a copper selenide. A detailed discussion of all processes other than double β decay which might contribute to the ^{130}Xe and ^{82}Kr anomalies is undertaken. It can be shown that these effects are small compared to the $\beta\beta$-decay process. It can be said now positively that $\beta\beta$-decay occurs in nature. Discussing all available data, the effective half life of ^{130}Te was determined to be 6×10^{20} yr and that of ^{82}Se equals 6×10^{19} yr. The results are in agreement with the theoretical predictions for the 2ν-$\beta\beta$-decay. Nevertheless, no-neutrino $\beta\beta$-decay is still possible. However, from the data it was calculated that the lepton nonconservation is at most 0.7%. (auth)

31747 SHELL STRUCTURE STUDIES IN THE TITANIUM REGION WITH 52-MeV DEUTERONS. Hinterberger, F.; Mairle, G.; Schmidt-Rohr, U.; Turek, P.; Wagner, G. J. (KFA, Juelich, Ger. Max-Planck-Institut fuer Kernphysik, Heidelberg). Z. Phys., 202: 236-54(1967).

The (d,^{3}He) reactions on the target nuclei ^{48}Ti, ^{50}Ti, and ^{51}V were studied with 52-MeV deuterons. The data were analyzed by means of the DWBA which is shown to be applicable at this energy. All the results agree well with the assumption of pure $(f_{\frac{7}{2}})^n$ proton configurations for these nuclei. The inelastic scattering of 52-MeV deuterons from the lowest 2^+ state in ^{48}Ti was described in terms of the collective model as well as of the microscopic shell model. Good fits to the measured angular distributions were obtained with reasonable values for the deformation parameters and the basic nucleon-nucleon interaction. (auth)

31748 STUDY OF THE LEVEL STRUCTURE OF ^{53}Cr AND ^{52}Cr WITH (d,d') AND (d,t) REACTIONS. Fitz, W.; Heger, J.; Jahr, R.; Santo, R. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Z. Phys., 202: 109-17(1967). (In German).

Angular distributions of deuterons and tritons from the reactions ^{52,53}Cr(d,d), ^{52,53}Cr(d,d'), ^{53,54}Cr(d,t)^{52,53}Cr were measured at E_d = 11.8 to 11.9 MeV. The elastic scattering data were analyzed in terms of the optical model. The (d,d') and (d,t) data were compared with DWBA calculations. Deformation parameters and spectroscopic factors were extracted. The results are qualitatively discussed in terms of different nuclear models. (auth)

31749 COLLECTIVE INTERMEDIATE STRUCTURE IN THE GIANT RESONANCE OF ^{28}Si. Seaborn, J. B.; Drechsel, D.; Greiner, W. (Univ., Frankfurt am Main). Z. Phys., 202: 32-7 (1967).

The theory of collective correlations is applied to ^{28}Si. The main structure of photonuclear experimental data is explained nearly quantitatively. A classification of the various structure as doorway- or one-particle one-hole structure, collective intermediate structure, and noncollective structure is proposed. (auth)

31750 ENERGY LEVELS OF ^{53}V AND THE ^{51}V(t,p)^{53}V REACTION. Vervier, J. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Phys. Lett., 24B: 603-5(June 12, 1967).

The energy levels of ^{53}V, its ground-state binding energy, and relative cross sections in the ^{51}V(t,p)^{53}V reaction are satisfactorily accounted for by shell-model calculations using effective nucleon-nucleon interactions. (auth)

31751 THERMAL NEUTRON ACTIVATION CROSS SECTION OF ^{74}Se. Steinnes, E. (Institutt for Atomenergi, Kjeller, Norway). J. Nucl. Energy, 21: 373-4(Apr. 1967).

Experiments are reported in which samples of selenium were irradiated for 1 to 20 hr in a pile or thermal column. Activities were measured by means of a gamma spectrometer using a NaI(Tl) crystal. The activation cross section of ^{74}Se was found to be 52 ± 3b. (UK)

31752 STUDY OF THE HIGH-ENERGY GAMMA RADIATION OF ^{77}Ge WITH THE AID OF A PAIR SPECTROMETER. Maria, Henriette; Dalmasso, Josette; Ythier, Christian (Faculte des Sciences, Nice). Compt. Rend., Ser. C, 264: 1677-9 (May 22, 1967). (In French).

The gamma radiation of ^{77}Ge above 1150 keV was studied using a pair spectrometer. The energies and relative intensities of 42 gamma rays were measured. (tr-auth)

31753 COULOMB DISPLACEMENT ENERGIES OF Ca–Sc ISOBARIC PAIRS. Nolen, J. A. Jr.; Schiffer, J. P.; Williams, N.; von Ehrenstein, D. (Argonne National Lab., Ill.). Phys. Rev. Lett., 18: 1140-3(June 19, 1967).

A new experimental technique was used to measure Coulomb displacement energies ΔE_C in the Ca−Sc isobaric pairs with A = 44, 46, 48, and 50. The reaction ^{46}Ca(He-3,d)^{47}Sc was used to measure this quantity for A = 47. This permits analysis of ΔE_C for all the isobaric pairs from A = 41 to 50, for the ground states and for several excited states, which yields a consistent picture. (auth)

31754 PROPERTIES OF ^{30}P LEVELS FROM THE ^{28}Si(p,γ)^{30}P REACTION. I. Harris, Gale I.; Hyder, A. K. Jr. (Aerospace Research Labs., Wright-Patterson Air Force Base, Ohio). Phys. Rev., 157: 958-67(May 20, 1967).

Gamma-ray decay schemes of seven resonances in the ^{28}Si(p,γ)^{30}P reaction in the range E_p = 700 to 1750 keV were studied in order to gain additional information on properties of resonant and bound levels of ^{30}P. The results also provide necessary information for the analysis of γ-ray angular-correlation and polarization measurements, which are in progress. Singles and coincidence spectra were obtained at each of the resonances at E_p = 730, 917, 1302, 1470, 1505, 1686, and 1748 keV (all ±2 keV) using large-volume NaI(Tl) detectors and a Ge(Li) detector. The resonance strengths were measured relative to the strength of the resonance at E_p = 416 keV in the same reaction, which is known from previous work. Consistent resonance decay schemes were derived, along with decay schemes of lower-lying bound states which, in many cases, differ considerably from previously available information. New results, or results significantly different from earlier reports, were obtained for the decay properties of the 3.02-, 3.74-, 3.93-, 4.14-, 4.18-, 4.23-, 4.43-, 4.50-, 4.62-, and 4.92-MeV levels of ^{30}P. The existence of a weak transition from the 4^-, 4.23-MeV level to the 1^+ ground state is shown. Another unusual transition found is one from the 3^-, 4.92-MeV level to the 1^+, 0.709-MeV level. The energies of 17 bound levels of ^{30}P were determined from the Ge(Li) data to a greater accuracy than heretofore available. Evidence is found for a previously unreported level at 4.468 ± 0.003 MeV, which is proposed to be the J = 0, T = 1 analog of the 3.79-MeV level of ^{30}Si. The decay schemes of the E_p = 730-, 917-, and 1302-keV resonances indicate they are quite pure T = 0 levels. The new value Q = 5.597 ± 0.003 MeV for the ^{28}Si(p,γ)^{30}P reaction was derived from the Ge(Li) spectra. (auth)

31755 LEVELS OF ^{29}Si BELOW 4.1-MeV EXCITATION ENERGY. Becker, J. A.; Chase, L. F. Jr.; McDonald, R. E. (Lockheed Palo Alto Research Labs., Calif.). Phys. Rev., 157: 967-76(May 20, 1967).

The states of ^{29}Si at 1.28-, 2.03-, 2.43-, 3.07-, 3.62-, and 4.08-MeV were studied using the particle-γ angular-correlation method of Litherland and Ferguson. The ^{28}Si(d,p)^{29}Si reaction was used to populate the levels of ^{29}Si at several bombarding energies in the neighborhood of 3 MeV. Charged particles were detected near 180° with respect to the incident-beam direction in a solid-state annular counter, and γ radiation was detected in a 10.2 × 10.2 cm NaI (Tl) crystal at angles between 0° and 90° relative to the incident-beam direction. The p-γ coincident data were stored in a 2-parameter pulse-height analyzer. Gamma-ray branching ratios derived from these data are presented for the levels mentioned above. In addition to an independent confirmation of the spin assignments $^3/_2$, $^5/_2$, and $^3/_2$ for the ^{29}Si levels at 1.28-, 2.03-, and 2.43-MeV, respectively, an assignment J = $^7/_2$ for the 3.62-MeV level and a most probable assignment J = $^5/_2$ for the 3.07-MeV level are established. For the 4.08-MeV level, J ≥ $^3/_2$. Some γ-ray mixing ratios are also presented, and an upper limit for the mean lifetime, $\tau_m \leq 90^{-8}$ sec, was obtained for all the levels studied. (auth)

31756 NUCLEAR STRUCTURE STUDIES OF ^{88}Sr AND ^{89}Y USING 19-MeV PROTON SCATTERING AND THE ^{88}Sr(^{3}He,d) REACTION. Stautberg, M. M.; Kraushaar, J. J.; Ridley, B. W. (Univ. of Colorado, Boulder). Phys. Rev., 157: 977-90(May 20, 1967). (UCOL-535-562).

Elastic and inelastic angular distributions were obtained for 19-MeV protons scattered from ^{88}Sr and ^{89}Y. Deuteron angular distributions were also obtained from the ^{88}Sr(^{3}He,d) reaction and used to study the single-particle nature of the excited states of ^{89}Y. Spectroscopic information was obtained by comparing the inelastic proton distributions with predictions of the distorted-wave theory using a real collective-model form factor. Proton angular distributions of the low-lying states of ^{89}Y and ^{88}Sr were compared to determine if the states of ^{89}Y could be explained as the weak coupling of the $2p_{\frac{1}{2}}$ proton to the core-excited states of ^{88}Sr. The states at 1.49 and 1.74 MeV in ^{89}Y do not appear to be described adequately as core-excited states, while the states at 2.22 (or 2.87) and 2.52 MeV do. The proton angular distributions for those states which could be described in terms of simple shell-model configurations were also analyzed with the distorted-wave theory using shell-model form factors. (auth)

31757 SEARCH FOR MEMBERS OF THE TWO-PHONON TRIPLETS IN ^{80}Se AND ^{80}Kr. Ramayya, A. V. (Vanderbilt Univ., Nashville); Hamilton, J. H.; van Nooijen, B.; Johnson, Noah R. Phys. Rev., 157: 1015-21(May 20, 1967). (ORNL-P-2765).

The γ rays emitted in the decay of ^{80}Br were investigated with Ge(Li) and NaI(Tl) spectrometers. Gamma rays (relative intensities are in parentheses) of 616.2 ± 0.5(100), 639.2 ± 0.7(3.6), 665.6 ± 0.5(17.2), 704.0 ± 0.7(2.9), 812.0 ± 1.5(0.8), and 1256.4 ± 1.5(1.0) keV were observed. Coincidence and $\gamma-\gamma$ directional correlation measurements were performed with two NaI detectors, a fast coincidence system, and a multiparameter analyzer to record the data. The coincidence studies indicated levels at 616.2 ± 0.5, 1255.6 ± 0.6, and 1320.2 ± 0.9 keV in ^{80}Kr, and 665.6 ± 0.5 and 1477.6 ± 1.6 keV in ^{80}Se. The experimental directional correlation coefficients of the 639.2-616.2-keV, 704.0-616.2-keV, and 812.0-665.6-keV cascades are $A_2 = -(0.12 \pm 0.04)$, $A_4 = +(0.38 \pm 0.10)$; $A_2 = +(0.38 \pm 0.06)$, $A_4 = +(1.28 \pm 0.18)$; and $A_2 = +(0.29 \pm 0.13)$, $A_4 = +(1.32 \pm 0.37)$, respectively. These values are compatible with spin assignments of 0^+ for the 1477.6-keV level in ^{80}Se, and of 2^+ and 0^+ for the 1255.6- and 1320.2-keV ^{80}Kr levels, respectively. (auth)

31758 ENERGY LEVELS OF ^{81}Br POPULATED BY THE DECAY OF ^{81m}Se AND ^{81}Se. Prawirosoehardjo, Soedijono (Pennsylvania State Univ., University Park). Phys. Rev., 157: 995-1000(May 20, 1967).

The γ rays following the decay of ^{81m}Se ($T_{\frac{1}{2}}$ = 57 min) and ^{81}Se ($T_{\frac{1}{2}}$ = 18 min) were investigated using a Ge(Li) detector, a $\gamma-\gamma$ coincidence apparatus, and a high-pressure gas proportional counter. ^{81m}Se and ^{81}Se were produced by neutron bombardment of 94.4% enriched ^{80}Se and natural selenium. Nine γ rays were identified as belonging to the decay of ^{81m}Se and ^{81}Se by using the Ge(Li) detector. The energies (in keV) and relative intensities (in brackets) of these γ rays are as follows. ^{81m}Se: 103.3 ± 0.2 (100) and 1146 ± 2 (3.4 ± 0.6). ^{81}Se: 276.3 ± 0.4 (100), 290.2 ± 0.4 (79.6 ± 5.6), 538.7 ± 0.7 (6.2 ± 0.7), 552.7 ± 0.7 (12.8 ± 1.4), 566.1 ± 0.7 (28.9 ± 2.6), 650.4 ± 0.9 (2.6 ± 0.4), and 829.2 ± 0.8 (36.6 ± 2.6). A γ ray of energy 180 ± 2 keV (relative intensity = 0.94 ± 0.19) was also attributed to ^{81}Se through $\gamma-\gamma$ coincidence measurements. An energy-level scheme of ^{81}Br populated by the decay of ^{81m}Se and ^{81}Se is proposed by introducing levels at 276, 566, 650, 815, 829, and 1146 keV. The 1146-keV level is fed by a direct β decay of ^{81m}Se with a transition intensity of (0.34 ± 0.13)%. The β-decay transition intensities of ^{81}Se to the 0-, 566-, 650-, 815-, and 829-keV levels of ^{81}Br were computed to be (98.8 ± 0.33)%, (0.76 ± 0.21)%, (0.014 ± 0.006)%, (0.042 ± 0.013)%, and (0.36 ± 0.10)%, respectively. (auth)

31759 STUDIES ON SOME LOW-LYING LEVELS OF ^{21}Ne. Howard, A. J. (Yale Univ., New Haven); Allen, J. P.; Bromley, D. A.; Olness, J. W.; Warburton, E. K. Phys. Rev., 157: 1022-32(May 20, 1967).

The ^{21}Ne states below an excitation energy of 5 MeV were studied via the ^{20}Ne(d,p)^{21}Ne and ^{20}Ne(d,pγ)^{21}Ne reactions with deuteron bombardment energies below 4 MeV. Angular-distribution measurements performed on the unresolved proton groups corresponding to formation of the 2.790- and 2.797-MeV ^{21}Ne states display $l_n = 0$ stripping characteristics. Based on the observed relative intensities of population for these two states in previous studies, this measurement is interpreted as direct evidence for a $J^\pi = ^1/_2^+$ assignment to the 2.797-MeV ^{21}Ne state. Two-parameter proton-gamma time-coincidence measurements were carried out to investigate the de-excitation branching ratios for the 1.75-, 2.87-, 3.67-, 3.74-, 3.89-, 4.53-, and 4.73-MeV ^{21}Ne states. Proton-gamma angular-correlation studies were performed in a colinear geometry at E_d = 3.0 MeV. The results confirm previous J = $^7/_2$ determinations for the 1.75-MeV ^{21}Ne state and indicate a value x = +(0.11 ± 0.03) for the multipole amplitude ratio of the 1.75 → 0.350 transition. They also indicate J = $^3/_2$ or $^5/_2$ for both the 3.67- and 3.74-MeV states and J ≥ $^3/_2$ for the 3.89-MeV state. All radiations originating from the 2.790-MeV state appeared isotropic within experimental uncertainties, and the present results indicate only that J ≤ $^5/_2$ for this state. The results of these and previous studies are compared with existing collective-model predictions concerning the ^{21}Ne nuclear system. (auth)

31760 HIGH-RESOLUTION STUDY OF THE ^{56}Fe(t,p)^{58}Fe REACTION. Cohen, B. L.; Fink, C. L.; Moorhead, J. B.; Moyer, R. A. (Univ. of Pittsburgh). Phys. Rev., 157: 1033-7(May 20, 1967).

The ^{56}Fe(t,p)^{58}Fe reaction was studied with 12-MeV incident tritons and a multigap magnetic spectrograph. Angular distributions were obtained for more than 60 transitions, and from them, angular-momentum transfers and hence spins and parities of states in ^{58}Fe are assigned. Results of the ^{57}Fe(d,p)^{58}Fe reaction are used in conjunction with these measurements to assign three unnatural parity states. The collective 3^- state is at 3.88 MeV. The ^{54}Fe(t,p) and ^{56}Fe(t,p) reactions are compared. (auth)

31761 PROTON TOTAL REACTION CROSS SECTIONS FOR 22 ISOTOPES OF Tl, Fe, Ni, Cu, Zn, Zr, AND Sn AT 14.5 MeV. Dicello, J. F.; Igo, G. J.; Roush, M. L. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 157: 1001-15(May 20, 1967).

Total proton reaction cross sections were measured at 14.5 MeV for 22 separated isotope targets to an accuracy of ±2% for Ti, Fe, Ni, Cu, Zn, and Zr isotopes and ±4½% for the Sn isotopes. A beam-attenuation technique employing a solid-state counter to detect elastically scattered protons at forward angles was used. Use of the solid-state detector reduces the corrections due to inelastic processes to a negligible level. The total reaction cross sections for the Fe, Ni, Zn, and Zr isotopes increased more rapidly with increasing N than optical-model calculations based on 14.5-MeV elastic-scattering and polarization data predict. The measured values for Fe, Ni, Cu, Zn, and Zr isotopes were generally smaller than the optical-model predictions; the measured Sn values, however, were larger. The dip in σ_R near Ni, previously observed using elemental targets in a number of experiments, is reproduced by suitable averaging of the isotope reaction cross sections. The dip is shown to arise from a combination of a sharply rising σ_R with increasing N (for constant Z) and the relatively small average value of N for Ni due to shell closure. (auth)

31762 INTERACTIONS OF 3.7-GeV/c ANTIPROTONS WITH Ag AND Br. Katcoff, Seymour (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 157: 1126-30(May 20, 1967). (BNL-10806).

Stars produced in low-sensitivity nuclear emulsions by 3.7-GeV/c antiprotons are compared with stars produced by protons of about the same momentum. The reaction cross section of the antiprotons is 880 mb for production of stars which can be identified as originating in Ag or Br (410 mb for protons). The α-particle and light-fragment prong distributions show that the antiprotons produce larger stars and therefore deposit more energy in the target nuclei. The production cross section for α's is 2750 mb; for light fragments ($3 \leq Z \leq 6$), 710 mb; for ^{8}Li fragments, ~29 mb. For proton-induced stars, these cross sections are 960, 270, and ~4 mb, respectively. The angular distribution of the recoiling residual

nuclei is considerably less forward-peaked for antiproton irradiation. Alpha-particle spectra show that antiprotons yield a broader distribution and relatively more low-energy particles. The angular distributions of both α's and light fragments are, respectively, very similar for the two types of irradiation. (auth)

31763 INFLUENCE OF SPIN-DEPENDENT LEVEL DENSITIES AND GAMMA-RAY COMPETITION IN THE DECAY OF HIGHLY EXCITED NUCLEI. Blann, Marshall (Univ. of Rochester, N. Y.). Phys. Rev., 157: 860-70(May 20, 1967).

Excitation functions for the $^{56}Fe(\alpha,pxn)$ reactions (x = 1 to 4) were calculated by the statistical theory of nuclear reactions, using optical-model transmission coefficients for neutrons, protons, and α particles and a level density of the form $\rho(E,J) \propto (2J+1)\rho(E-E_{rot})$, where $E_{rot} = J(J+1)\hbar^2/2\mathcal{I}_{rig}R$. Here $\mathcal{I}_{rig}$ is the rigid-body moment of inertia, and the dimensionless parameter R was taken in different calculations as 1 or ∞. Where a rigid-body moment of inertia was used, two assumptions were made concerning γ-ray de-excitation: It was assumed that (a) there was no γ-ray competition if the excitation energy exceeded the minimum nucleon binding energy, or (b) there was no γ-ray competition if the excitation exceeded the binding energy plus rotational energy for each spin. Of the three sets of calculations, the latter set gave the best overall agreement with experimental (α,pn) and $(\alpha,p2n)$ excitation functions. Calculations were also performed for the $^{48}Ti(^{12}C,pxn)$ excitation functions (where $^{48}Ti + {}^{12}C$ forms the same compound nucleus as $^{56}Fe + \alpha$), where x = 1 to 4, with R = 1.0, and assumption (b) concerning γ-ray–nucleon emission competition. It is concluded that excitation-function measurements to test the influence of angular momentum on the independence hypothesis should show observable differences in shape and energy dependence, but that a good knowledge of E and dE/dX for the heavy ion is required if one is to be confident of the interpretation of the results. The influence of γ-ray competition based on assumption (b) is considered as a function of mass number of the compound nucleus; the qualitative differences expected for actual excitation functions with respect to the predictions of the Weisskopf–Ewing evaporation model with no γ-ray competition should decrease with an increase in mass number. Specifically, excitation functions from lower-mass compound nuclei should be broader, should be displaced to higher energies, and should have more pronounced high-energy tails than those from heavier-mass systems. (auth)

31764 STRUCTURE OF THE CROSS SECTION OF THE REACTION $^{40}Ca(\gamma,p)$. Goryachev, B. N.; Ishkhanov, B. S.; Kapitonov, I. M.; Piskarev, I. M.; Shevchenko, V. G.; Shevchenko, O. P. (Moscow State Univ.). JETP Lett. (USSR) (Engl. Transl.), 5: 180-1(Apr. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 225-7(Apr. 1, 1967).

The cross section of the reaction $^{40}Ca(\gamma,p)^{39}K$ was measured using bremsstrahlung with maximum energies in the range 8 to 30 MeV. The yields were measured for two proton energy groups $E_p \geq 2$ MeV and $E_p \geq 7$ MeV. In the former case, maxima were observed at $E_\gamma = 12.7 \pm 0.2$, 18.7 ± 0.2, 19.9 ± 0.2, 20.9 ± 0.2, 21.8 ± 0.2, 23.2 ± 0.3, 25.0 ± 0.5, and 28.0 ± 0.5. The integrated cross section up to 30 MeV is 510 ± 70 MeV-mb. (D.C.W.)

31765 THE ANALYSIS OF THE TWICE-FORBIDDEN β-TRANSITIONS. Kopytin, I. V. (Voronezh State Univ., USSR). Yadern. Fiz., 5: 976-82(May 1967). (In Russian).

The normal and unique twice-forbidden β-transitions as well as a unique three-times-forbidden transition in the nucleus ^{40}K are considered in terms of Fermi-liquid theory. The f_0t-values and the shape factors for the normal β-transitions and $f_2^{(un)}t$-values for the unique ones are calculated. The results given by the conserved vector current theory are shown to be in satisfactory agreement with experimental data. (auth)

31766 225-MeV ELECTRON SCATTERING FROM THE NUCLEI ^{89}Y AND ^{93}Nb. Shevchenko, N. G.; Afanas'ev, N. G.; Savitskii, G. A.; Khvastunov, V. M.; Kovalev, V. D.; Omelaenko, A. S.; Gul'karov, I. S. Yadern. Fiz., 5: 948-58(May 1967). (In Russian).

The absolute differential cross sections were measured for the elastic and inelastic scattering of the electrons from the nuclei ^{89}Y and ^{93}Nb at angles from 25 to 105°. The elastic scattering data indicate that the two-parameter Fermi model description is in good agreement with charge distribution in the ground states of these nuclei. Some information concerning the excited levels is obtained from the inelastic scattering data. (auth)

31767 ENERGY AND ANGULAR DISTRIBUTION OF α PARTICLES FROM THE REACTION (n,α) ON THE NUCLEI Ag AND Br. Kuz'min, V. A.; Ostroumov, V. I. (Leningrad Polytechnic Inst.). Yadern. Fiz., 5: 937-41(May 1967). (In Russian).

The reaction (n,α) on the emulsion heavy nuclei was investigated by the nuclear photographic plate method at neutron energies 15.1 and 21.8 MeV. The obtained energy spectra and angular distributions indicate that the investigated reaction proceeds considerably via direct interaction. The energy spectrum of α particles emitted by the nuclei Ag and Br in the direct process resembles the evaporation spectrum of α particles at their energies up to 8 MeV. (auth)

31768 SOME PROPERTIES OF THE MECHANISM OF REACTIONS WITH MANY-NUCLEONS TRANSFER. Vil'chinski, Ya.; Volkov, V. V.; Detsovski, P. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 942-7(May 1967). (In Russian).

The reaction $(^{14}N, {}^{18}F)$ on the ^{27}Al target nucleus was investigated. Experiments were performed at four different energies of the incident ^{14}N ions: 65.0, 78.7, 91.4 and 107.3 MeV. The energy distributions of the ^{18}F reaction products at different angles were measured. Besides the products of the transfer reaction ^{27}Al $(^{14}N, {}^{18}F)$ ^{22}Na, the ^{18}F nuclei of significantly lower energy were observed in the energy distributions. A contribution of the low-energy ^{18}F products increases quickly with energy of the ^{14}N ions and with increasing angle. An interpretation of the results in terms of two different mechanisms of the $^{27}Al(^{14}N, {}^{18}F)$ reaction is suggested. The energy distributions of the ^{18}F nuclei from the reaction $^{27}Al(^{15}N, {}^{18}F)$ at energies of the ^{15}N ions 96.5 and 78.5 MeV are also presented. (auth)

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Refer also to abstracts 31710, 31714, 31734, 31736, 31737, 31739, 31743, 31746, 31761, 31762, 31766, 31767, 31829, 31834, 31836, 31843, 31847, 31849, and 31880.

31769 (AE–280) ON THE MAGNETIC PROPERTIES OF THE K = 1 ROTATIONAL BAND IN ^{189}Re. Malmskog, Sven G.; Hoejeberg, Mats (Aktiebolaget Atomenergi, Stockholm (Sweden)). May 1967. 19p. Dep.

The transitions in the decay of the 18.6-min ^{189}Re isomer were studied with a Ge(Li) detector. Two previously unreported weak gamma transitions of 156 and 169 keV were found and were interpreted as cross-over transitions. From a delayed coincidence experiment using a double-lens electron-electron coincidence spectrometer, the half life of the first excited 63.6-keV level in ^{189}Re was determined to be 56 ± 7 psec. The half lives of the first excited 2^+ levels in ^{188}Os and ^{186}Os were also measured and were found to be 0.81 ± 0.03 nsec and 0.68 ± 0.03 nsec, respectively. (auth)

31770 (BMwF-FBK-67-04) UNTERSUCHUNG DER STREUUNG SCHNELLER NEUTRONEN NACH DER LAUFZEITMETHODE MIT HILFE EINES VAN DE GRAAFF-GENERATORS. (Investigation of the Scattering of Fast Neutrons by the Time-of-Flight Method by Means of a Van de Graaff Accelerator). Moll, A.; Johnsen, P.; Wollesen, M. (Kiel Univ. (West Germany). Institut fuer Reine und Angewandte Kernphysik). Jan. 1967. 22p. (In German). Dep.

The status of a fast neutron scattering experiment, in which a Van de Graaff accelerator with a pulse length of about 0.6 nsec and a pulse frequency of 2 MH_z is used, is summarized. The flight path is 1.5 m in length, and pulsing is performed using a deflection condenser and a slit diaphragm. (D.C.M.)

31771 (BNL–11474) ANALOG SIMULATION OF CESIUM PRODUCTION. Rothbart, Michael A.; Galanter, Leonard (Brookhaven National Lab., Upton, N. Y.). June 1967. 27p. (CONF-670602–13). Dep. CFSTI.

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif.

An analog simulation of the production of Cs isotopes, particularly ^{134}Cs, in the thermal neutron fission of ^{235}U is outlined. The analog computer is briefly described, and the differential equations used are given. (D.C.W.)

31772 (CEA–R–3047) CONTRIBUTION A L'ETUDE DES NIVEAUX EXCITES DU SAMARIUM 151. (Contribution to the Study of ^{151}Sm Excited Levels). Locard, Pierre (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1967. 125p. (In French). Dep.

Thesis. Univ. of Grenoble, France.

The energy levels of ^{151}Sm were investigated by measuring gamma spectra in the decay of ^{151}Pm. Direct gamma spectra were measured using a Ge(Li) detector, and coincidence spectra were obtained using a scintillation spectrometer. A level scheme is proposed for ^{151}Sm including levels at 245.6, 306.6, 522, 952, and

962 keV. The half lives of a few levels were measured, and the multipolarities of the main transitions were verified. Spin assignments were proposed for the low-lying levels of ^{151}Sm. The experimental results were compared with the predictions of collective models. (D.C.W.)

31773 (COO-1505-17) DEEXCITATION PROCESSES IN HIGH-ENERGY NUCLEAR REACTIONS. Progress Report, February 1966-April 1967. Porile, Norbert T. (Purdue Univ., Lafayette, Ind. Dept. of Chemistry). May 1967. Contract AT-(11-1)-1505. 31p. Dep. CFSTI.

Progress is reported on the following research: formation of ^{24}Na in the interaction of 11.5-GeV protons with Pb and U isotopes; cross sections and recoil properties of Ag and Pd nuclides produced in the fission of ^{238}U by 0.45- and 11.5-GeV protons; recoil study of reactions of Ag and In with 200- and 400-MeV protons; and angular distributions of products from ^{65}Cu(^{3}He,xn) reactions. (S.F.L.)

31774 (INP-529/PL) TERNARY FISSION OF ^{236}U. Benisz, Jerzy; Panek, Tadeusz (Institute of Nuclear Physics, Krakow (Poland)). Mar. 1967. 23p. Dep.

The ternary fission mechanism of ^{236}U with the emission of a particle with $Z > 2$ was investigated. The average value of the total kinetic energy of ternary fission fragments was found to be 202 MeV. The measured ratio of the ternary fission cross section to the binary fission cross section is about 10^{-3}. (auth)

31775 (INR-787/VI/PH) CORRELATED PROTON PAIRS IN A HIGH ENERGY NUCLEAR REACTION. Siemiarczuk, Teodor; Zielinski, Przemyslaw (Institute of Nuclear Research, Warsaw (Poland)). 1967. 7p. (CONF-670207-5). Dep.

From 2nd International Conference on High Energy Physics and Nuclear Structure, Rehovoth, Israel.

The emission of correlated proton pairs in 780 interactions of 9 GeV negative pions with xenon nuclei was observed. (auth)

31776 (JINR-P6-3312) ISSLEDOVANIE RASPADA ^{160}Tb → ^{160}Dy. (The Decay ^{160}Tb → ^{160}Dy). Vrzal, Ya.; Galan, P.; Galanova, T. I.; Liptak, Ya.; Urbanets, Ya.; Finger, M. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1967. 39p. (In Russian). Dep.

The gamma spectrum of ^{160}Tb was investigated using two germanium semiconductor detectors. The absolute intensities and multipolarities of γ transitions in a ^{160}Dy nucleus were investigated. A conclusion was drawn about the two-quasiparticle nature of the 1264.4-keV energy level, and an assumption was made about the existence of rotational band on this state. Experimental data are compared with the predictions of different nuclear models. (auth)

31777 (MLM-1388) MOUND LABORATORY QUARTERLY PROGRESS REPORT, JULY-SEPTEMBER 1966. (Mound Lab., Miamisburg, Ohio). Sept. 30, 1966. Contract AT(33-1)-Gen-53. 35p. Dep. CFSTI.

The half lives of ^{211}Pb and ^{210}Po were determined using the decaying pair method, and neutron yields from the reaction ^{19}F(α,n)^{22}Na on thick targets were measured. High-purity ^{234}U was separated from aged ^{238}Pu using an anion exchange-hexone extraction-anion exchange method, and it was determined that ^{229}Th could be separated from aged ^{233}U by solvent extraction using di-sec-butyl phenyl phosphonate in diethyl benzene. A live-timer system that permits the direct determination of the resolving time of a proportional counter was developed, and the reduction of data in the measurement of fast neutron spectra using stilbene-crystal spectrometers was studied. A method for determining boron and boron isotopes using neutron activation was also developed, and electron inductive effects in substituted polystyrenes were investigated by NMR spectroscopy. (D.C.W.)

31778 (NAS-NRC/PUB-1292-C) NUCLEAR CHEMISTRY: A CURRENT REVIEW. (National Academy of Sciences-National Research Council, Washington, D. C.). 1966. 53p. NAS-NRS.

A review is presented on current trends in nuclear chemistry including: research on nuclear properties and reactions; atomic and molecular problems; research on the macroscopic world; role of nuclear chemistry in the national nuclear energy program and instrumentation. The present organization of research and training in nuclear chemistry is also discussed. (P.C.H.)

31779 (ORNL-TM-1860) SPECTROSCOPIC STUDY OF THE PROTON GROUND STATE CONFIGURATIONS IN THE ZIRCONIUM ISOTOPES. Preedom, Barry Mason (Oak Ridge National Lab., Tenn.). June 1967. Contract W-7405-eng-26. 109p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

A distorted-wave analysis was made of (d,^{3}He) data to provide information concerning the structure of the nucleus. It was found that the DW calculations predicted the shape of the observed proton transfers very well. The calculations could also predict the specific variations in the angular distributions that were observed for different $j(l \pm \frac{1}{2})$ transfers. Because of the unique DW predictions for each assumed l and j, it was possible to assign spins and parities to the different states in the residual nuclei. Uncertainties exist when the DW analysis is used to obtain spectroscopic information concerning the absolute values for the populations of different configurations. The uncertainty arising from the lack of specific knowledge about the bound-state wave function was investigated. It was seen that the magnitude of the predicted angular distributions, and thus the extracted spectroscopic strengths, are quite sensitive to the parameters of the bound-state well. The uncertainty involved in selecting a single parametric set for this well is reflected in the values of the absolute spectroscopic factors. Even with this difficulty, the magnitude of the values are within 30% of the sum-rule limits. To display the systematics of the data, relative spectroscopic factors were presented for each isotope. Uncertainties in these values are dependent on the ability of the DW theory to correctly predict the (n,l,j) and Q-dependence, and on the relative experimental errors which are mainly statistical in nature. It was found that these relative spectroscopic factors were consistent from one isotope to another. By using the relative values for the spectroscopic strengths, this work can be interpreted in terms of a simple shell model picture. It was found that the admixture of the $(2p_{\frac{1}{2}})^2$ and $(1g_{\frac{9}{2}})^2$ proton configurations changes as $2d_{\frac{5}{2}}$ neutrons are added. The relative amounts of the mixture are 64% $(2p_{\frac{1}{2}})^2$ and 36% $(1g_{\frac{9}{2}})^2$ in the ground state of ^{90}Zr. The $(2p_{\frac{1}{2}})^2$ mixture decreases to 55% for ^{92}Zr and then increases to 66% for ^{94}Zr and 86% in the ground state of ^{96}Zr. Thus, it is concluded that the $2d_{\frac{5}{2}}$ neutron shell has an effect on the proton configuration through the p-d and g-d proton-neutron interactions. The observed changes in the $(2p_{\frac{1}{2}})^2$ and $(1g_{\frac{9}{2}})^2$ proton admixture provide a measure of the relative strengths of these interactions. (auth)

31780 (UCRL-17536) POLARIZATION OF INDIUM NUCLEI IN FERROMAGNETS AND NUCLEAR MAGNETIC RESONANCE OF POLARIZED COBALT IN IRON. Holliday, Rondel James (California Univ., Berkeley. Lawrence Radiation Lab.). May 1967. Contract W-7405-eng-48. 47p. Dep. CFSTI.

Thesis.

The hyperfine magnetic fields at In nuclei dissolved in iron and nickel were determined by low-temperature nuclear orientation of ^{114m}In in iron and nickel. ^{57}Co was used as the thermometer. The results are: H_{int}(In in Fe) = −295 ± 10 kG, H_{int}(In in Ni) = 42 ± 6 kG. Nuclear magnetic resonance was observed in ^{60}Co nuclei polarized in iron at low temperatures. The resonance frequency is 165.75 ± 0.15 MHz. (auth)

31781 (UR-3591-5) NUCLEAR REACTION MECHANISMS. Progress Report, May 1, 1966-May 1, 1967. Blann, Marshall (Rochester Univ., N. Y. Dept. of Chemistry). Contract AT-(30-1)-3591. 169p. Dep. CFSTI.

Recoil ranges and excitation functions were measured for alpha-particle reactions with ^{90}Zr at 20 to 80 MeV, with ^{197}Au at 20 to 100 MeV, and ^{51}V at 5 to 120 MeV. The data were analyzed using the statistical theory with different level density models and different assumptions on the competition between γ-ray and nucleon emission. Recoil ranges for ^{55}Co, ^{56}Co, ^{57}Co, and ^{58}Co from deuteron-induced reactions on ^{58}Ni at 5.5 and 19.8 MeV were measured as were the angular distributions of Co recoil nuclei from alpha-particle reactions with ^{59}Co and ^{58}Ni at 62 MeV. Recoil ranges were used to test the "universal" range theory of Lindhard, Scharff, and Schiott. A chamber was developed for measuring heavy-ion energy losses in gaseous media, and a heavy ion source was developed for addition to a duoplasmatron proton source. (D.C.W.)

31782 POLARIZATION MEASUREMENTS NEAR ISOBARIC ANALOGS OF STATES IN N = 83 ISOTOPES. Veeser, L.; Ellis, J.; Haeberli, W. (Univ. of Wisconsin, Madison). Contract AT(11-1)-Gen-7. Phys. Rev. Lett., 18: 1063-5(June 12, 1967). (COO-7-0413).

Measurements of the polarization of protons scattered from barium and cerium were made to determine the total angular momenta, J, of isobaric analogs of states in ^{139}Ba and in ^{141}Ce. The second p-wave state in each case was found to have angular momentum $\frac{1}{2}$ in contrast to previous assignments of $J = \frac{3}{2}$ to this level. (auth)

31783 STUDY OF NUCLEAR LEVELS OF ^{220}Fr EXCITED IN THE α DISINTEGRATION OF ^{224}Ac. Briand, J. P. (Univ., Paris). Nucl. Phys., A99: 28-40(1967). (In French).

In the α disintegration ^{224}Ac $\xrightarrow{\alpha}$ ^{220}Fr two new α-rays were observed and values of absolute α-intensities measured. By γγ,αγ coincidence methods, the different modes of disintegration of ^{220}Fr nuclear levels are studied; many γ-transitions were observed and analyzed. A disintegration scheme is presented. (auth)

31784 COINCIDENCE AND DIRECTIONAL CORRELATION MEASUREMENTS ON THE DECAY OF ^{160}Tb EMPLOYING A Ge(Li) DETECTOR. Jaklevic, J. M.; Funk, E. G.; Mihelich, J. W. (Univ. of Notre Dame, Ind.). Contract AT(11-1)-498. Nucl. Phys., A99: 83-99(1967). (COO-498-61).

Coincidence and directional correlation measurements employing a 2 mm Ge(Li) detector and a 7.6 cm × 7.6 cm NaI detector were performed on the decay of ^{160}Tb to levels in ^{160}Dy. Relative gamma-ray intensities were determined from analysis of Ge(Li) singles spectra and coincidence measurements. Internal conversion coefficients were calculated by normalizing the gamma-ray intensities to the internal conversion electron intensities of Ewan et al. A previously unreported 1105 keV gamma ray was placed in the decay scheme. Gamma-gamma directional correlations were measured for cascades involving transitions of the following energies (keV): 879.5-86.8, 962.0-86.8, 1177.4-86.8, 1270.6-86.8, 215.2-962.0, 298.5-879.5 and 298.5-966.0. Branching ratios for E2 transitions de-exciting levels in the gamma-band and E1 transitions de-exciting the negative parity states were calculated, and comparisons were made with theoretical estimates. (auth)

31785 SPIN ASSIGNMENTS OF LOW-ENERGY RESONANCES IN ^{239}Pu. Asghar, M. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Phys., A98: 33-40(1967).

Neutron scattering measurements were made up to about 300 eV on ^{239}Pu. Combining these data with the published transmission data ($g\Gamma_n\Gamma$), spin assignments of 50 resonances were made. If the resonances assigned by other workers are included, the average values of fission widths for 0^+ and 1^+ resonances up to 200 eV are found to be 479.4 and 37.6 MeV, respectively. It is shown that this average value of fission width (37.6 MeV) for 1^+ resonances is inconsistent with the hypothesis of 1^+ resonances fissioning through a 1^+ two quasi-particle transition state and one needs a 1^+ transition state at a much lower energy to account for this result. This state may be a 1^+ combination transition state formed from mass asymmetry and bending vibrations. (auth)

31786 RELATIVE INTENSITY AND CONVERSION COEFFICIENTS OF THE TRANSITIONS IN THE DECAY ^{95}Zr → ^{95}Nb → ^{95}Mo. Eissa, N. A. (Al Azhar Univ., Cairo); Meligy, Z.; El Farrash, A. H.; Girgis, S. Acta Phys. Acad. Sci. Hung., 23: 67-73(1967).

The external and internal conversion spectra in the decay of ^{95}Zr-^{95}Nb were measured in a double-focusing beta spectrometer. Applying the correction for the anisotropic distribution of the photoelectrons ejected from a uranium convertor, it was possible to determine accurately the relative gamma ray intensities of the 237-, 726-, and 757-keV transitions in ^{95}Nb and the 762- and 765-keV transitions in ^{95}Mo. Applying the internal-external conversion method, the absolute k-conversion coefficients were determined for the above transitions. The 237-keV transition was found to be M_4 transition and the 726-keV transition is an M_1 transition, while the other ones are M_1 or E_2 transitions. The spin of the level at 726 keV in ^{95}Nb has value of $\frac{7}{2}^+$. (auth)

31787 EFFECT OF DOPPLER BROADENING ON THE ABSORPTION INTEGRAL OF THE 1.056 eV RESONANCE OF ^{240}Pu. Cupini, E. (CNEN, Bologna); De Matteis, A.; Loizzo, P. Energ. Nucl. (Milan), 14: 321-3(May 1967).

The Monte Carlo method was used to calculate the capture probability relative to the 1.056-eV resonance of ^{240}Pu. A series of Monte Carlo calculations was carried out for typical H_2O-moderated lattices, and the parameters of a semiempirical formula fitting the Monte Carlo results were determined. (D.C.W.)

31788 STATIC QUADRUPOLE MOMENT OF THE FIRST 2^+ STATE IN ^{114}Cd MEASURED BY COULOMB EXCITATION. Glenn, J. E.; Saladin, J. X. (Univ. of Pittsburgh). Phys. Rev. Lett., 19: 33-6(July 3, 1967).

The ratio of the inelastic cross section to the elastic cross section for the scattering of ^{16}O ions by ^{114}Cd at 42 MeV was measured, and the static quadrupole moment of the 0.558-MeV state of ^{114}Cd was obtained from the data using a Coulomb-excitation program that solves the time-dependent Schroedinger equation for the transition amplitudes. (D.C.W.)

31789 INVESTIGATION OF ANOMALOUS K-, L-, AND M-SHELL CONVERSION IN ELECTRIC DIPOLE TRANSITIONS. Pauli, Hans-Christian; Alder, Kurt (Univ. of Basel). Z. Phys., 202: 255-72(1967).

Anomalous experimental conversion coefficients of the K, L, and M subshells are investigated for thirteen highly hindered electric dipole transitions in six deformed odd-mass nuclei. For a distinct nuclear transition, all experimental anomalies are consistent with one parameter, containing all nuclear information. The values of this parameter are determined, and a simple connection with the hindrance of the transition seems to exist. The K- and L-shell conversion coefficients were recalculated, while the M-shell conversion data were newly computed including all finite nuclear size effects as well as screening by a Thomas-Fermi-Dirac model. (auth)

31790 CONCERNING INTERNAL CONVERSION COEFFICIENTS IN ^{180}Hf. Nelson, G. C.; Hatch, E. N. (Ames Lab., Iowa). Contract W-7405-eng-82. Z. Phys., 202: 293-300(1967). (IS-1543).

The gamma relative intensities from transitions in ^{180}Hf following the 5.5-hour ^{180m}Hf decay were measured using a bent-crystal gamma diffraction monochromator and a least-squares fitting technique. From these measurements it was possible to deduce a value for the internal conversion coefficient for the 93.3-keV transition of $\alpha_T^{93} = 4.91 \pm 0.23$. From previous measurements of conversion electron intensities by Edwards and Boehm and the gamma relative intensities, internal conversion coefficients for all transitions except the 57.5-keV transition were obtained. These coefficients agree well with the previous determinations by Edwards and Boehm, however, the present measurements have improved precision, particularly in the case of 501.3-keV transition. The present measurements of α_K for the 215.3-, 332.5- and 443.8-keV E2 transitions are 11% lower than theoretical values while α_K for the 93.3-keV E2 transition agrees closely with the theoretical value. These results are in close agreement with the previous measurements of Edwards and Boehm. The present experimental α_K for the 501-keV transition agrees closely with the theoretical α_K for an E3 multipolarity. (auth)

31791 INTERPRETATION OF THE EXPERIMENTAL EVIDENCE CONCERNING THE QUADRUPOLE MOMENT OF ^{209}Bi: A TEST OF THE SHELL MODEL. Powers, R. J.; Telegdi, V. L. (Univ. of Chicago). Z. Phys., 202: 214-19(1967).

Attempts are made to construct a model of the quadrupole moment of ^{209}Bi which will be consistent with the hfs interaction constant and the ^{209}Bi-^{208}Pb isotope shift observed in muonic x rays. Good agreement is achieved by postulating that the ^{209}Bi quadrupole moment is due to a single proton in an $h_{\frac{9}{2}}$ state and to a distorted ^{208}Pb core which has a deformation of about 1%. The inferred quadrupole moment is found to be 0.37 barn of which 0.12 barn is due to the distorted core. (auth)

31792 SURFACE DELTA INTERACTION AND ELECTROMAGNETIC TRANSITIONS IN TIN AND LEAD ISOTOPES. Yucker, W.; Plastino, A.; Moszkowski, S. A. (Univ. of California, Los Angeles). Z. Phys., 202: 177-81(1967).

Electric quadrupole and octupole transition rates are calculated in even Pb and Sn isotopes using wave functions obtained with a surface delta interaction. The agreement with experimental results is better than in previous calculations which used a pairing plus quadrupole (or octupole) or a Gaussian interaction. (auth)

31793 MASS SPECTROMETRIC METHOD FOR IDENTIFICATION AND NUCLEAR SPECTROSCOPIC STUDY OF SHORT-LIVED FISSION PRODUCTS. Hovestadt, D.; Armbruster, P. (Technische Hochschule, Munich). Nukleonik, 9: 338-46(Apr. 1967). (In German).

A method for the nuclear spectroscopic study of the decay of short-lived ^{235}U fission products is described. A He-filled mass separator of 5% resolution is used. Fission products of a given mass region were deposited on a nylon film. The film is introduced periodically into a β-γ coincidence apparatus and the activity is studied. A description of the apparatus is given and calculations on periodically operating measurement methods β coincidence γ spectra from the region of light fission products are presented. (tr-auth).

31794 MEASUREMENT OF THE BURNUP STATE OF SPHERICAL REACTOR FUEL ELEMENTS USING A HIGH RESOLUTION SEMICONDUCTOR γ SPECTROMETER. Bueker, Harald (Kernforschungsanlage, Juelich, Ger.). Nukleonik, 9: 346-51(Apr. 1967). (In German).

A measurement method for the determination of the burnup states of spherical fuel elements is described. The method makes it possible to carry out nondestructive and rapid burnup determinations from γ spectroscopy. The measurement apparatus contains a high-resolution photopeak γ spectrometer provided with a Li-drifted Ge semiconductor detector. The ^{137}Cs photoline at 662 keV is used as the reference line for the measurement. Its intensity is a measurement of the burnup. The workability of the measurement device is proved for various strongly burned-up fuel samples. (tr-auth)

31795 ELECTRON-CAPTURE INTENSITIES IN THE DECAY OF ^{133}Ba. Schulz, G. (Univ., Heidelberg). Z. Phys., 203: 289-95(1967).

The ground-state decay of ^{133}Ba was investigated using NaI(Tl) scintillation crystals. P_L/P_K electron-capture ratios were mea-

sured for the transitions to the 437-keV and the 384-keV level of ^{133}Cs. The results are: $(P_L/P_K)_{437} = 0.371 \pm 0.007$ and $(P_L/P_K)_{384} = 0.221 \pm 0.005$. From these data, a mass difference between the ground states of the ^{133}Ba and the ^{133}Cs atoms of 515 ± 3 keV was derived. Besides, these capture ratios yield an exchange correction of 1.03 ± 0.03. Furthermore, the intensity of the transition to the 161-keV level was determined to be smaller than 0.5% of all decays. (auth)

31796 EXCITED STATES OF DEFORMED ODD–ODD ATOMIC NUCLEI. Begzhanov, R. B.; Isakov, B.; Sharipov, Sh. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uz. SSR, Ser. Fiz.-Mat. Nauk, No. 2, 57-60(1967). (In Russian).

The influence of nuclear deformation on the excited states of odd-odd nuclei at arbitrary magnitudes of the deformation parameter μ in the range of $0 \leq \mu \leq 1$ was studied using odd nuclei with ground-state spin $^9/_2$. The diagram of the parameter μ as a function of the spin sequence and the energies of energy levels of the ground-state rotational single-particle band of odd nuclei, with a ground-state spin of $^9/_2$, is given, and theoretical and experimental spins and energies of excited states of ^{187}Re and ^{225}Ra nuclei are tabulated. It is shown that the changes in nuclear shape produce a significant effect on the excited states in odd atomic nuclei. (R.V.J.)

31797 MEASUREMENT OF THE TOTAL NEUTRON CROSS SECTION OF TANTALUM IN THE ENERGY RANGE 0,002 TO 0,2 eV USING A TIME-OF-FLIGHT SPECTROMETER. Adib, M.; El-Ela, M. Abu; Salama, M.; Kawy, A. Abdel; Hamouda, I. (Atomic Energy Establishment, Cairo). J. Nucl. Energy, 21: 425-6(May 1967).

Tantalum samples of 5 and 3 g/cm^2 thickness were prepared from powder by pressing. The results of measurements are shown. A value of 6.23 ± 0.31 b was obtained for the potential scattering cross section. Steps were found in the curve corresponding to the crystal planes (200) and (110). (UK)

31798 ENERGY DEPENDENCE OF $\bar{\nu}_p$ FOR NEUTRON-INDUCED FISSION OF ^{235}U BELOW 1.0 MeV. Meadows, J. W.; Whalen, J. F. (Argonne National Lab., Ill.). J. Nucl. Energy, 21: 157-69(Feb. 1967).

The energy dependence of $\bar{\nu}_p$, the average number of prompt neutrons per fission, was measured over the incident neutron energy range 0.04 to 1.0 MeV by measuring the ratio of prompt neutrons from neutron-induced fission of ^{235}U to those from spontaneous fission of ^{252}Cf. It was confirmed that $\bar{\nu}_p$ is not a monotonically increasing function of energy below 0.6 MeV. Above 0.6 MeV, $d\bar{\nu}_p/dE_n \simeq 0.14$ MeV^{-1}, in good agreement with the assumption that all the kinetic energy of the incident neutron appears as internal excitation of the fragments. (UK)

31799 INVESTIGATION ON THE ANGULAR DISTRIBUTION OF NEUTRON-INDUCED ^{238}U FISSION BY MEANS OF A SOLID-STATE TRACK DETECTOR. Csikai, J.; Nagy, S. (ATOMKI, Debrecen, Hungary). J. Nucl. Energy, 21: 375-6(Apr. 1967).

A uranium target of 1mg/cm^2 was prepared on aluminum foil. Results of measurements made using glass detectors at 14.7 MeV are shown graphically. (UK)

31800 STUDY OF γ RADIATION ACCOMPANYING THE DECAY $^{171}Hf \rightarrow {}^{171}Lu$. Gizon, J.; Jourdan, A.; Peyrard, M.; Valentin, J. (Faculte des Sciences, Grenoble, France). J. Phys. (Paris), 28: 249-56(Mar.-Apr. 1967). (In French).

Using separated-isotope sources, iron-free double-focusing spectrometers for conversion electrons, and a Ge(Li) detector for gamma rays, the energies, multipole orders, and relative intensities of 13 gamma rays in the decay of ^{171}Hf were determined. The results are discussed. (auth)

31801 DEUTERONS, TRITONS, AND HELIUM IONS FROM DIRECT INTERACTION EVENTS OF 156-MeV PROTONS WITH MEDIUM AND HEAVY NUCLEI. Dubost, H.; Batty, B.; Lefort, M.; Peter, J.; Tarrago, X. (Faculte des Sciences, Orsay, France). J. Phys. (Paris), 28: 257-70(Mar.-Apr. 1967). (In French).

A telescopic device made of four solid-state detectors was used in order to identify deuterons, tritons, and helium ions and to measure their energy when they are ejected from Ag and Au targets bombarded by 156-MeV protons. Some results were also obtained at 90 MeV. The multidimensional analysis of dE/dx and E data was made with an electronic computer. The angular distribution has shown that, besides the isotropic process attributed to the "evaporation" mechanism, direct interaction events were observed in the forward direction. The ^4He emission can be explained quantitatively by the so call "knock-out" mechanism in which prompt cascade nucleons enter in collision with α substructures. Deuterons, tritons, and ^3He are believed to be attributed to indirect pick-up processes which occur between prompt cascade nucleons and neutrons on the nucleus surface. (auth)

31802 DETERMINATION OF MULTIPOLARITIES OF ELECTROMAGNETIC NUCLEAR TRANSITIONS. APPLICATION TO THE DECAYS $^{170}Hf \rightarrow {}^{170}Lu$; $^{177}W \rightarrow {}^{177}Ta$. Husson, J. P. (Institut de Physique Nucleaire, Orsay, France). J. Phys. (Paris), 28: 271-6(Mar.-Apr. 1967). (In French).

The multipolarities of gamma transitions in the two decays were determined by measurement of their conversion coefficients through simultaneous recording of β and γ spectra using a Si junction for the electrons and a Ge(Li) junction for the gamma rays. (D.C.W.)

31803 FISSION AND ABSORPTION g-FACTORS OF ^{241}Pu. Lemmel, H. D.; Westcott, C. H. (IAEA, Vienna). J. Nucl. Energy, 21: 417-24(May 1967).

The effective cross section of a Maxwellian neutron spectrum can be given as the product of the cross section at 0.0253 eV and the "g-factor". Fission and absorption g-factors of ^{241}Pu are calculated from various cross-section measurements and are tabulated in the temperature range 0 to 2000°C. Some discrepancies between different measurements are discussed. (UK)

31804 AVERAGE WIDTHS FOR HIGH-ENERGY RADIATIVE TRANSITIONS. Bollinger, L. M.; Thomas, G. E. (Argonne National Lab., Ill.). Phys. Rev. Lett., 18: 1143-7(June 19, 1967).

The average gamma spectrum formed when neutrons that are distributed in a relatively broad band of energy are captured in many resonances is directly measured. The application of this method to a study of the dependence of the radiation width on gamma energy is described. The method of measurement consists of observing with a Ge-diode gamma spectrometer the captured gamma rays emitted by a ^{10}B-surrounded target placed in a high-flux reactor. The average spectrum for the reaction $^{195}Pt(n,\gamma)^{196}Pt$ found using this method is shown. (J.F.P.)

31805 RELATIVE INTENSITIES OF THE L-SHELL INTERNAL-CONVERSION LINES OF PURE E2 ($2+ \rightarrow 0+$) TRANSITIONS IN RARE-EARTH NUCLEI. Gelletly, W.; Geiger, J. S.; Graham, R. L. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Rev., 157: 1043-9(May 20, 1967).

Accurate measurements of L-shell internal-conversion line intensity ratios are reported for four low-energy E2 transitions in ^{156}Gd, ^{160}Dy, ^{168}Er, and ^{170}Yb. The measurements were made using a 100-cm radius iron-free $\pi\sqrt{2}$ double-focusing β spectrometer at resolution settings of 0.03 to 0.09% in momentum. Different source and detector arrangements were used to explore for possible systematic effects. In all cases the experimental L_{II}/L_{III} intensity ratios agreed with the corresponding theoretical ratios to $\leq 2\%$. The L_I/L_{II} and L_I/L_{III} experimental ratios are systematically larger than the theoretical values by an average of 5.4%. (auth)

31806 SLOWING OF FISSION FRAGMENTS IN NOBLE GASES. Moore, M. S.; Miller, L. G. (Idaho Nuclear Corp., Idaho Falls). Phys. Rev., 157: 1049-54(May 20, 1967).

Measurements were made which give information on the slowing of ^{235}U fission fragments by gaseous and metallic-foil absorbers. Emphasis was placed on slowing of fragments by noble gases: helium, neon, argon, krypton, and xenon. The data show significant discrepancies from the existing theory, and suggest that it is necessary to take into account the effects of electronic shell structure of the fragment in treating the slowing-down process. (auth)

31807 VARIATION WITH NEUTRON ENERGY OF THE YIELD OF HIGH-KINETIC-ENERGY FRAGMENTS FROM ^{233}U, ^{235}U, AND ^{239}Pu. Miller, L. G.; Moore, M. S. (Idaho Nuclear Corp., Idaho Falls). Phys. Rev., 157: 1055-9(May 20, 1967).

A fission chamber was devised which detects with high efficiency those fission events in which the kinetic-energy release of the heavier binary fragment is maximal. This detector was used, in conjunction with a conventional fission detector (with efficiency independent of fragment energy), in a study of the relative yield of high-kinetic-energy fission of ^{233}U, ^{235}U, and ^{239}Pu, induced by low-energy neutrons. The variations in the yield of high-kinetic-energy fragments shows a qualitative correlation with results of measurements of the relative symmetric fission yield as a function of neutron energy. The results indicate that an increase in symmetric fission is accompanied by an increased yield of certain high-kinetic-energy fragments. Such behavior shows that the fission process is more complex than has generally been assumed. (auth)

31808 NUCLEAR RESONANCE FLUORESCENCE IN ^{185}Re. Metzger, F. R. (Franklin Inst., Swarthmore, Pa.). Contract AT(30-1)-3525. Phys. Rev., 157: 1060-5(May 20, 1967). (NYO-3525-14).

The resonant scattering of γ rays from the 646-, 718-, and 874-keV excited states of ^{185}Re was observed with NaI as well as with

Ge(Li) detectors. An ^{185}Os source, moving on the periphery of a fast rotor at speeds of up to 1.3×10^5 cm/sec, provided the resonant γ rays. From the magnitude of the scattering effects, values of $g\Gamma_\gamma^2/\Gamma = (2.37 \pm 0.15) \times 10^{-5}$, $(4.8 \pm 1.0) \times 10^{-5}$, and $(2.7 \pm 0.3) \times 10^{-4}$ eV were obtained for the widths of these levels, respectively. The angular distributions of the resonance radiations were found to be consistent with the previously accepted spin assignments of $\frac{1}{2}$ to the 646-keV level, $\frac{3}{2}$ to the 718-keV level, and $\frac{1}{2}$ or $\frac{3}{2}$ to the 874-keV level. A comparison of resonance scattering and Coulomb-excitation cross sections made it possible to eliminate spin $\frac{1}{2}$ for the 874-keV level. A value 1.18 ± 0.06 was measured for the ratio of the intensities of the 874- and 879-keV γ rays emitted in the disintegration of ^{185}Os. Evidence for the existence of a level in ^{185}Re at 929 ± 2 keV was obtained, and upper limits of 0.2% of the ground-state transitions were established for the branchings from the 874- and 879-keV levels to the $\frac{7}{2}^+$ first excited state. (auth)

31809 VIBRATIONAL SPECTRUM OF ^{114}Cd. Comfort, J. R. (Yale Univ., New Haven); Bockelman, C. K.; Barnes, P. D. Contract AT(30-1)-3223. Phys. Rev., 157: 1065-76(May 20, 1967).

The energies and angular distributions of proton groups produced in the ^{113}Cd(d,p)^{114}Cd reaction were measured with an overall resolution of 12 keV. A distorted-wave analysis, employing experimentally determined optical-model parameters, was used to extract values of l_n and spectroscopic strengths for states up to 3.8-MeV excitation in ^{114}Cd. The spectroscopic factors of the low-energy states are compared with those predicted by a microscopic theory of nuclear vibrations. Reasonable agreement is found for the ground and one-quadrupole-phonon states, but not for the two-phonon states. (auth)

31810 ^{252}Cf FISSION NEUTRON SPECTRUM FROM 0.003 TO 15.0 MeV. Meadows, J. W. (Argonne National Lab., Ill.). Phys. Rev., 157: 1076-82(May 20, 1967).

The spontaneous-fission neutron spectrum of ^{252}Cf was measured from 0.003 to 15.0 MeV by time-of-flight techniques. A hydrogenous liquid scintillator was used as a detector at the higher energies, while a ^{6}Li-loaded glass scintillator was used at the lower energies. The measured spectrum has an average energy of 2.348 MeV. A Maxwellian distribution, $N(E) \sim E^{\frac{1}{2}} \exp(-E/1.565)$, fits the data well for $0.5 < E < 10.0$ MeV. Below 0.1 MeV, N(E) has a $\sqrt{E}$ dependence but with values ~25% larger than those predicted by the extended Maxwellian spectrum. The results are interpreted in terms of a simplified evaporation model. (auth)

31811 BENT-CRYSTAL SPECTROMETER MEASUREMENT OF THE INTENSITIES OF X RAYS COINCIDENT WITH FISSION OF ^{235}U. Wehring, Bernard W.; Wyman, Marvin E. (Univ. of Illinois, Urbana). Phys. Rev., 157: 1083-92(May 20, 1967).

A measurement of the intensities of K x rays from fission fragments was made using a bent-crystal spectrometer of the Johansson type. The experiment was a coincidence experiment with only those x rays in coincidence with a fission event being counted. A wire coated with enriched uranium was placed in a thermal-neutron beam and served as the fission source. This wire was both the center wire for a fission ionization chamber and the x-ray source for the bent-crystal spectrometer. In order to maintain sufficient sensitivity, resolution was sacrificed. The resolution, however, was still good enough to resolve the Kα lines of adjacent elements of the light fragments. The experimental results for the prompt K x-ray intensities are compared with calculated initial yields versus atomic number. The apparent x-ray yield per fragment as a function of charge does not vary slowly with charge but is what one might expect for electronic vacancy production due to internal conversion by the de-exciting fragments. This effect appears to be more pronounced for thermal-neutron-induced fission of ^{235}U than spontaneous fission of ^{252}Cf. (auth)

31812 ALPHA-GAMMA ANGULAR CORRELATIONS IN THREE HEAVY ODD-A NUCLIDES. Hutchinson, J. M. R. (National Bureau of Standards, Washington, D. C.). Phys. Rev., 157: 1093-8(May 20, 1967).

Angular correlations between alpha particles and gamma rays were measured in liquid sources of three separate nuclides, ^{243}Am, ^{233}U, and ^{237}Np. The angular-correlation functions were experimentally determined for five transitions, and the relative angular-momentum mixing ratios for these transitions were deduced. The mixing ratios of L = 2 and 0 agree with theory, but the L = 4 and 2 mixing ratios are somewhat higher than predicted. Upper limits of the half-lives of 99-keV and 45-keV states in ^{229}Th were measured, respectively, as 0.8×10^{-9} and 1.2×10^{-9} sec. From a comparison of the attenuated angular correlation in ^{243}Am, and a previously measured angular correlation in ^{241}Am, it is deduced that an extranuclear interaction occurs with a time duration less than 1.2×10^{-9} sec. (auth)

31813 DECAY OF ^{124}Sb TO ^{124}Te. Stelson, P. H. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Rev., 157: 1098-1108(May 20, 1967). (ORNL-P-2806).

The γ rays from 60-day ^{124}Sb were measured with a Ge γ-ray detector. Gamma–gamma coincidence and correlation measurements were made with a Ge detector and a NaI scintillation detector. Beta–gamma coincidences were made using a Ge detector and anthracene scintillation detector. The Ge detector was placed in a large NaI annulus detector to provide both anticoincidence Compton-suppressed spectra and high-resolution γ-ray pair spectra. A total of 25 γ rays was observed. A level scheme is proposed which contains 13 levels. Angular correlation measurements confirm a spin-4 assignment to the 1247.6-keV state and show that the spin of the 1325.0-keV state is 2 and that the 722.5-keV γ ray to the first 2^+ state has a mixture $\delta \equiv (E^2/M1)^{\frac{1}{2}} = 3.4 \pm 0.6$. Two levels at 1956.5 and 2038 keV have properties which are consistent with a three-phonon collective-state interpretation. (auth)

31814 INTERNAL CONVERSION COEFFICIENTS WITH RELATIVISTIC HARTREE–FOCK MODEL FOR THE DEFORMED REGION. Bhalla, C. P. (Argonne National Lab., Ill. Univ. of Alabama, Huntsville. Kansas State Univ., Manhattan). Phys. Rev., 157: 1136-43(May 20, 1967).

Internal conversion coefficients for E2 transitions in six cases of the deformed nuclear region are presented. New calculations are based upon the relativistic Hartree-Fock potential in the Slater-exchange approximation with the inclusion of only the static finite-nuclear-size effects. For the $2^+ \rightarrow 0^+$ transitions in ^{156}Gd, ^{160}Dy, ^{166}Er, ^{170}Yb, ^{186}Os, and ^{188}Os, a comparison of present calculations with the weighted mean of all experimental values for L_1/L_2 indicates that the latter are larger by (6.2 ± 3)%, (5.9 ± 4.3)%, (8.4 ± 4.4)%, (7.3 ± 3.9)%, (7.5 ± 6.4)%, and (2.8 ± 5.6)%, respectively. Corresponding results for L_1/L_3 are (5.5 ± 1.8)%, (5.5 ± 2.5)%, (6.3 ± 2.3)%, (5.5 ± 2.4)%, (6.6 ± 4.6)%, and (4.3 ± 4.1)%. The uncertainties assigned to the percentage deviations correspond to an estimate of error at approximately 90% confidence level. Deviations of about the same magnitudes were pointed out by several experimentalists in a comparison with the calculations of Sliv and Band and of Rose. Numerical results are also given for the K subshell and M subshells in the above cases. It is suggested that M-subshell ratios be measured. A comparison of the experimental M-subshell ratios and K-conversion coefficient (within an accuracy of 2% or so) would provide additional information so that the origin of deviations in L-subshell ratios could be pinpointed. A possible explanation may be the effects of nuclear deformation on the L_1 internal conversion coefficient. (auth)

31815 NUCLEAR STRUCTURE IN ^{127}Te FROM THE ^{126}Te(d,p) REACTION. Cohen, B. L. (Univ. of Pittsburgh); Fink, C. L.; Hinds, S. Phys. Rev., 157: 1144-8(May 20, 1967).

The ^{126}Te(d,p)^{127}Te reaction induced by 13-MeV deuterons was studied with the Aldermaston multigap spectrograph. Essentially all states up to 2.7-MeV excitation were observed, although a few unresolved doublets were found in higher-resolution studies. Of the 8 holes in the 50–82-neutron shell, 2.9 are in $d_{\frac{5}{2}}$, 1.0 is in $s_{\frac{1}{2}}$, and 4.2 are in $h_{\frac{11}{2}}$. These results agree well with pairing-theory predictions, but are considerably different from the results for the isotonic nucleus studied in ^{124}Sn(d,p)^{124}Sn reactions. 67% of the $d_{\frac{5}{2}}$ strength, 83% of the $s_{\frac{1}{2}}$ strength, and 100% of the $h_{\frac{11}{2}}$ strength are in single nuclear states, the three lowest-energy states in ^{127}Te. (auth)

31816 INTERACTION OF FAST NEUTRONS WITH ORIENTED ^{165}Ho. Fisher, T. R. (Stanford Univ., Calif.); Safrata, R. S.; Shelley, E. G.; McCarthy, J.; Austin, S. M.; Barrett, R. C. Phys. Rev., 157: 1149-66(May 20, 1967).

Total cross-section and angular distribution measurements are reported for 8- and 15-MeV neutrons incident on unoriented ^{165}Ho. Measurements of the "deformation effect" in the total cross section for unpolarized neutrons incident on oriented ^{165}Ho at 8 and 15 MeV are also reported. The first and second moments of the nuclear orientation were $B_1/B_1(\max) = +0.55$ and $B_2/B_2(\max) = +0.25$. If the "deformation effect" is defined by $\Delta\sigma_{\text{Def}} = \sigma(\text{oriented}) - \sigma(\text{unoriented})$, the experimental results for $\Delta\sigma_{\text{Def}}$ are -38 ± 10 mb and -139 ± 16 mb at 8 and 15 MeV, respectively. The above data are explained by a coupled-channel analysis based on the rotational optical model, and the optical parameters derived from this analysis are used to interpret a measurement of the "spin-spin effect" at $E_n = 7.85$ MeV. The neutron polarization for the measurement was 0.34. If the "spin-spin effect" is defined by $\Delta\sigma_{ss} = \sigma_{\uparrow\uparrow} - \sigma_{\uparrow\downarrow}$, the experimental result for $\Delta\sigma_{ss}$ is $+3 \pm 13$ mb at $E_n = 7.85$ MeV. If $\Delta\sigma_{ss}$ is assumed to arise from a term of the form $-V_{ss} f(r, r_0 A^{\frac{1}{3}}, a) \times \mathbf{I} \cdot \sigma/\hbar$ in the optical potential, the acceptable limits on the strength of the potential are -340 keV $< V_{ss} < 540$ keV. The experimental results are compared with other published data on the interaction of neutrons with oriented ^{165}Ho. (auth)

31817 LOW-LYING EXCITED STATES OF ^{108}Ag AND ^{110}Ag POPULATED IN THERMAL-NEUTRON-CAPTURE REACTIONS. Bolotin, H. H.; Namenson, A. I. (Argonne National Lab., Ill.). Phys. Rev., 157: 1131-6(May 20, 1967).

The thermal-neutron-capture γ-ray spectra following the reactions ^{107}Ag(n,γ)^{108}Ag and ^{109}Ag(n,γ)^{110}Ag were studied with the aid of a Ge(Li) detector operated in the singles and pair-spectrometer modes. The use of isotopically enriched targets led to unambiguous assignments of 33 primary transitions in ^{108}Ag and 46 transitions issuing from the capture state in ^{110}Ag. In each nuclide, these transitions were used to define the low-lying states to an accuracy of ~±1 keV up to an excitation energy of ~1300 keV. The observed strengths of the primary transitions are examined to determine the possible presence of systematic regularities of the type reported in the type reported in the rare-earth rotational region. Comparisons are made between these data and previous (d,p) studies with a view toward establishment of the parity of the states populated in both reactions. (auth)

31818 THE SHORT-LIVED ISOMER OF ^{98}Nb. Hubenthal, Karlheinz; Monnand, Edouard; Moussa, Andre (CEN, Grenoble, France). Compt. Rend., Ser. A and B, 264: 1317-20(May 3, 1967). (In French).

The existence of a 2.8 sec isomer of ^{98}Nb produced by the reactions ^{98}Mo(n,p)^{98}Nb with 14.3-MeV neutrons was shown. This isomer decays essentially by emission of a spectrum of β radiations with maximum energy of the order of 4.5 MeV. Some γ transitions at 780, 1020, and 1400 keV as well as a conversion ray at 715 keV were also found. (tr-auth)

31819 PARAMETERS OF THE LEVELS OF ^{239}Pu. Ryabov, Yu. V.; Wang, Yung-chang; Dermendzhiev, E.; Chang, Pei-shu (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 925-8(May 1967). (In Russian).

The JINR fast pulsed reactor was used to measure the fission and radioactive capture cross sections of ^{239}Pu by time-of-flight method with the resolution of 0.06 μsec/m. The measurements were made with cadmium liquid scintillation detector. The values Γ_f/Γ and $g\Gamma_n$ were obtained in the neutron energy range up to 100 eV using the area method. (auth)

31820 SPECTRA OF CONVERSION ELECTRONS IN THE THERMAL NEUTRON CAPTURE BY ^{151}Eu AND ^{153}Eu. Bondarenko, V. A.; Prokof'ev, P. T.; Simonova, L. I. (Inst. of Physics, Riga). Yadern. Fiz., 5: 929-32(May 1967). (In Russian).

Spectra of conversion electrons from the ^{151}Eu(n,γ)^{152}Eu and ^{153}Eu(n,γ)^{154}Eu reactions are investigated with a β-spectrograph. In the electron energy region from 35 up to 180 keV the spectrum of ^{152}Eu contains 74 lines and in the region of 35 to 225 keV 66 lines are found to exist in ^{154}Eu spectrum. The multipole orders are determined for some of the transitions. (auth)

31821 ACTIVATION OF SHORT-LIVED ISOMERS OF STABLE NUCLEI BY ^{116m}In GAMMA-RAYS. Abrams, I. A.; Pelekis, L. L. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 1, 3-6(1967). (In Russian).

The short-lived isomers ^{79m}Br, ^{167m}Er, ^{179m}Hf, ^{77m}Se, ^{107m}Ag, and ^{109m}Ag were obtained by inelastic scattering of ^{116m}In gamma rays. The half-lives, activation cross sections, and energies of the isomeric transitions were determined. (auth)

31822 MEASUREMENTS OF TRANSVERSE POLARIZATION OF THE INNER CONVERSION ELECTRONS IN THE β-DECAY. Tret'yakov, E. F. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 5: 1037-41(May 1967). (In Russian).

Measured transverse polarizations of the inner conversion electrons at the β-decays of ^{131}I, ^{153}Sm, ^{166}Ho, ^{170}Tm, ^{186}Re, ^{188}Re are given. The results are compared with the theoretical values and with the data of other works. (auth)

31823 ON PROPERTIES OF NUCLEI IN DEFORMATION REGIONS; ODD NUCLEI NEAR TO Os. Berlovich, E. E. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 5: 988-95 (May 1967). (In Russian).

It is shown that the correlation exists between the mode of the nuclear shape variation with the mass number increasing (discontinuous or continuous variation) and the orbital properties of the self-consistent field. Large values of the inner quadrupole moments for the nuclei containing 90 neutrons are explained qualitatively with the contribution from the odd nucleon to the nuclear deformation estimated after the experiment. The ^{193,195,197}Au nuclei belonging to the deformation region are shown to have the equilibrium deformation from 0.08 to 0.1 while in the $11/2^-$ state these nuclei are spherical. The $1/2^+$ states of three nuclei are of more complicated nature. (auth)

31824 NUCLEAR FISSION INTO THREE FRAGMENTS INDUCED BY HEAVY IONS. Karamyan, S. A.; Kuznetsov, I. V.; Oganesyan, Yu. Ts.; Penionzhkevich, Yu. E. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 959-65(May 1967). (In Russian).

Fission into three fragments having approximately equal masses is observed after bombarding ^{197}Au, ^{209}Br and ^{238}U with the ^{22}Ne and ^{40}Ar ions at an energy up to 8 MeV per nucleon. Semiconductor surface-barrier detectors were used to record the ternary fission. The experimental results are explained in terms of the cascade mechanism for the fission of the excited nucleus when the asymmetrical binary fission is accompanied by the subsequent fission of the heavy fragment. The experiments were performed with the JINR Laboratory of Nuclear Reactions 310 cm heavy-ion cyclotron. (auth)

31825 CROSS SECTIONS AND ANGULAR ANISOTROPY OF FISSION FRAGMENTS FOR FISSION OF SOME ISOTOPES Pu, Am, AND Cm BY FAST NEUTRONS. Fomushkin, E. F.; Gutnikova, E. K.; Zamyatnin, Yu. S.; Maslennikov, B. K.; Belov, V. N.; Surin, V. M.; Nasyrov, F.; Pashkin, N. F. Yadern. Fiz., 5: 966-70(May 1967). (In Russian).

The fission-fragment glass detector and impulse ionization chambers were used to measure the cross sections and angular anisotropy of fission fragments for fission of ^{238}Pu, ^{242}Pu, ^{241}Am, ^{243}Am, ^{242}Cm and ^{244}Cm by 14.5 MeV neutrons and fission spectra neutrons. The obtained results agree with the modern classification of fission cross sections and angular distributions of fission fragments. (auth)

31826 DECAY OF ^{149}Gd, ^{149}Eu, AND ^{151}Gd. Avotina, M. P.; Grigor'ev, E. P.; Zolotavin, A. V.; Sergeev, V. O.; Vrzal, Ya.; Liptak, Ya.; Lebedev, N. A.; Urbanets, Ya. (Leningrad State Univ. Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1304-13(Aug. 1966). (In Russian).

Beta and γ spectrometers were used for studying levels of ^{149}Eu, ^{151}Eu and ^{149}Sm. Energy level transitions, relative intensities of conversion electrons and γ rays, conversion coefficients, and multiplicity of transitions in ^{149}Gd, ^{149}Eu, and ^{149}Sm are tabulated and decay schemes are presented and analyzed. The probability of transitions in europium nuclei showed a considerable increase of B(E2, $7/2^+ \rightarrow 5/2^+$) and B(E3, $11/2^- \rightarrow 5/2^+$) and reduced B(M2, $11/2^- \rightarrow 7/2^+$). The probabilities of magnetic dipole transitions B(M1, $1/2^+ \rightarrow 5/2^+$) change insignificantly for $^{147-151}$Eu and drop for ^{153}Eu. (R.V.J.)

31827 IONIZATION BY FISSION PRODUCTS AND DECAY ELECTRONS. Nguyen, Dong Huu. Berkeley, Calif., Univ. of California, 1966. 229p.

Thesis.

The space-dependent ion production rate in a medium by fission products and decay electrons produced in another adjacent medium is studied in this work. It is found that significant ionization is induced in a noble gas (Ar, Ne) by fission products escaping from a fuel element in a reactor of moderate neutron flux. For instance, about 3.5×10^{13} ion pairs/cm^3 sec are produced in Ne for a flux of 6×10^{10} neutrons/cm^2 sec. According to existing experimental work on MHD plasmas induced by fission fragment ionization, this ion production rate corresponds to a conductivity of $\sim 1.4 \times 10^{-3}$ (ohm-meters)$^{-1}$ in a gas mixture Ne + 0.1% Ar at 200 mm Hg and 400°K and at an electric field of 560 V/m. The ionization by decay electrons contributes only about 3.0% of the total ionization in Ne and 5.0% in Ar. Because fission products have very small ranges in solids, they lose a significant amount of energy before escaping from the source medium. The Bohr stopping equation is shown to reduce to the energy-distance "square law" when an approximation of Z_{eff} by the Thomas–Fermi atomic model is used. It is then used to obtain the energy flux carried by the fragments at a spatial point in the outer medium. The energy deposition per unit volume per second is obtained by taking the spatial derivative of the energy flux. By dividing the energy deposition by the w-value of the medium, one obtains the ion production rate in that medium. The Alexander–Gazdik empirical range-velocity relationship is also used to calculate the ion production rate by fission products in a medium. The results show that, with the same values of the fragment ranges, the Alexander–Gazdik relationship yields higher ion production rate than that given by the Bohr theory. Because of scattering, electrons slow down in a medium under the combined effects of energy loss and direction changes. A method is presented to solve the Lewis electron transport equation for the detailed electron flux distribution in a medium. The distribution in the initial direction μ' contained in the "scattering-in" integral is expanded in a Taylor's series about the final direction μ, thus forming the moments of the scattering kernel. Use is made of the predominant small-angle scattering to retain only the first moment, thus reducing the differential-integral equation to a first order partial differential equation in three variables (x,μ,t), which is then solved by the method of characteristics. The method is used to obtain the electron range-energy relation which is in excellent agreement with range measurements in Al. The space-dependent energy

deposition per unit volume per second is then obtained by multiplying the detailed flux by the stopping equation dE/ds and integrating over all directions and energies. The ion production rate is obtained by dividing the energy deposition by the w-value of the medium in consideration. (TSS)

Nuclear Theory

Refer also to abstracts 30641, 31555, 31700, 31703, 31715, 31728, 31731, 31737, 31747, 31763, 31771, 31791, 31792, 31796, and 31814.

31828 (CEA-Bib-83) DIFFUSION ELASTIQUE ET INELASTIQUE DE PROTONS POLARISES. (Elastic and Inelastic Scattering of Polarized Protons). Locard, Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr. 1967. 54p. (In French). Dep.
Thesis.

A method of measuring the polarization of proton beams is described, and the information that can be obtained by measuring the polarization of scattered protons is analyzed. The optical-model analysis of elastic scattering and the analysis of inelastic scattering by the distorted-wave Born approximation are discussed in detail. Experimental data are compared with theoretical predictions. (D.C.W.)

31829 (COO-1573-13) SYSTEMATICS OF MUON CAPTURE IN A NUCLEAR SHELL MODEL. Bogan, Alexander Jr. (Case-Western Reserve Univ., Cleveland, Ohio. Dept. of Physics). June 1967. Contract AT(11-1)-1573. 146p. Dep. CFSTI.
Thesis. Submitted to Case Inst. of Tech., Cleveland, Ohio.

The implications of the universal Fermi interaction (UFI) hypothesis with bare V-A coupling and conserved vector current to the total rate for muon capture in nuclei are reviewed. The total capture rates for many nuclei are calculated in a closure approximation using a nuclear shell model. It is found that restricting the model to stable nuclei greatly reduces the scatter about a straight line on a Primakoff plot. The values predicted for the weak interaction coupling constants assuming reasonable values for the average momentum of the emitted neutrinos are about two-thirds of the UFI values or, if one accepts the UFI coupling constants, the necessary neutrino momentum is found to be about 10% less than one would expect. The sources of error in this model are discussed, and it is concluded that the inability to accurately predict the total capture rate stems from the difficulty in choosing an appropriate average neutrino momentum as required by the closure approximation. (auth)

31830 (GA-7417(Rev.)) GASKET: A UNIFIED CODE FOR THERMAL NEUTRON SCATTERING. Koppel, J. U.; Triplett, J. R.; Naliboff, Y. D. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Mar. 10, 1967. Contract AT(04-3)-167. 124p. Dep. CFSTI.

The computer program GASKET is described as it existed on Sept. 22, 1966. (D.C.W.)

31831 (INP-536/PL) ZJAWISKA POLARYZACYJNE W STRUKTURZE JADER ATOMOWYCH. (Polarization Phenomena in Nuclear Structure). Bochnacki, Z. (Institute of Nuclear Physics, Krakow (Poland)). Mar. 1967. 41p. (In Polish). Dep.

A review of the theory of the polarization effects in nuclei is presented. Special attention is given to the problem of the residual interaction in nuclei. (auth)

31832 (INR-540/PL) ELASTIC ELECTRON SCATTERING FROM NUCLEI AND NUCLEON-NUCLEON CORRELATIONS. Czyz, W.; Lesniak, L. (Institute of Nuclear Research, Krakow (Poland)). Apr. 1967. 9p. Dep.

Arguments that elastic electron scattering from nuclei at large momentum transfers is very sensitive to the dynamical short range nucleon-nucleon correlations are given. (auth)

31833 (INSJ-104) PHENOMENOLOGICAL DISCUSSIONS ON ENERGY LEVELS, GAMMA TRANSITIONS, AND BETA TRANSITIONS OF MEDIUM-HEAVY NUCLEI. Ejiri, Hiroyasu (Tokyo Univ. (Japan). Inst. for Nuclear Study). May 6, 1967. 39p. Dep.

Phenomenological discussions are made on the uniform property of the ground-state band levels in so-called spherical, transition, and deformed nuclei. The ground-state band structure throughout all even-even nuclei consists of levels with spin sequence 0^+, 2^+, 4^+, 6^+, ... and has generally some uniform properties of energy spectra, gamma transitions, and beta transitions. The excitation energy of the ground-state band level with spin I^+ is expressed by a simple form $E(I) = kI(I+1) + aI$. In this expression the coefficient k keeps approximately constant in nuclei with the same atomic number and depends slightly on the mass number, while the parameter a is characteristic of each nucleus. The reduced E2 transition probability between the ground-state band levels decreases gradually with the increase of the energy deviation term from the pure rotational motion. Using a unit of the B(E2) of pure rotational motion with energy spectrum $kI(I+1)$, one gets the relations $\sqrt{B(E2)} = u + ve^{-wa}$ with the one parameter a. Beta transitions from odd-odd nuclei to the ground-state band levels are hindered much more as the spins of the parent nuclei become larger. This fact just corresponds to the K selection rule. The ground-state band levels have uniform property as $K = 0$ in the beta transition. The existence of the uniform properties of the ground-state band levels shows that the properties expected for well-defined deformed nucleus persist more or less in all even-even nuclei. (auth)

31834 (ORNL-4082) PHYSICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1966. Stelson, P. H. (ed.) (Oak Ridge National Lab., Tenn.). May 1967. Contract W-7405-eng-26. 175p. Dep. CFSTI.

OXYGEN-16 — deuteron reactions (d,α) at 3.0 to 5.2 MeV, differential cross sections for, (E)
INVARIANCE PRINCIPLES — time reversal testing by nitrogen-14(α,d) and oxygen-16(d,α) reactions, (E)
RADIUM-226 — proton fission at 6 to 13 MeV, fission-fragment angular distributions and cross sections for, (E)
NEUTRONS, PROMPT — emission in proton fission of uranium-235, (E)
URANIUM-235 — proton fission at 13 MeV, prompt neutron emission in, (E)
OSMIUM-186, OSMIUM-188, OSMIUM-190, OSMIUM-192, TUNGSTEN-182, TUNGSTEN-184, TUNGSTEN-186 — energy-level transition probabilities from oxygen-16 inelastic scattering with Coulomb excitation, (E)
OXYGEN-16 — scattering by silver-107 and silver-109 at 45.5 MeV with Coulomb excitation, gamma spectra from, (E)
SILVER-107 — energy-level spins and transitions from alpha and oxygen-16 inelastic scattering with Coulomb excitation, (E)
SILVER-109 — energy-level spins and transitions from alpha and oxygen-16 inelastic scattering with Coulomb excitation, (E)
XENON-136 — proton differential elastic and inelastic scattering cross sections at 9.8 to 12.6 MeV, (E)
CESIUM-137 — energy levels from proton elastic and inelastic scattering by xenon-136, (E)
YTTRIUM-89 — proton reactions (p,n) at 3.6 to 5.1 MeV, cross sections near isobaric analog resonances, (E)
ZIRCONIUM-90 — energy levels from yttrium-89 (p,n) reactions at 3.6 to 5.1 MeV, (E)
TIN-117 — proton reactions (p,n) at 4.4 to 4.7 MeV, cross sections and spectra near isobaric analog resonances, (E)
TIN-119 — proton reactions (p,n) at 4.4 to 4.7 MeV, cross sections and spectra near isobaric analog resonances, (E)
ANTIMONY-117 — energy levels from tin-117 (p,n) reactions, spins of, (E)
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ZIRCONIUM-89 — energy levels from yttrium-89 (p,n) reactions, spin and parity of 1105-keV, (E)
YTTRIUM-89 — proton reactions (p,n) at 5.50 and 5.77 MeV, neutron angular distributions and spectra from, (E)
COPPER-65 — helium-3 reactions (He-3,d) at 18 MeV, differential cross sections and spectra for, (E)
ZINC-66 — energy levels from copper-65 (He-3,d) reactions, spectroscopic factors for, (E)
CALCIUM-40 — neutron total cross sections and resonance parameters at 1.0 to 2.1 MeV, (E)
NEUTRONS, FAST — reactions with calcium-40 at 1.0 to 2.1 MeV, total cross sections and resonance parameters for, (E)
CALCIUM-41 — energy levels from neutron scattering by calcium-41, resonance parameters for, (E)
NITROGEN-14 — neutron total cross sections and resonance parameters at 2.0 to 4.2 MeV, (E)
TIN-116, TIN-119, TIN-122, TIN-124 — neutron capture by, gamma spectra from resonance and thermal, (E)
TIN-117 — energy levels from resonance and thermal neutron capture by tin-116, (E)
TIN-120 — energy levels from resonance and thermal neutron capture by tin-119, (E)
TIN-123 — energy levels from resonance and thermal neutron capture by tin-122, (E)
TIN-125 — energy levels from resonance and thermal neutron capture by tin-124, (E)
ALUMINUM-27, IRON-56, TIN-118, TIN-124 — neutron resonance capture by, gamma spectra from, (E)

TUNGSTEN-182, TUNGSTEN-184, TUNGSTEN-186—neutron capture by, gamma spectra from thermal, (E)
TUNGSTEN-187—energy-level transitions from tungsten-186 thermal-neutron capture, (E)
TUNGSTEN-185—energy-level transitions from tungsten-184 thermal-neutron capture, (E)
TUNGSTEN-183—energy-level transitions from tungsten-182 thermal-neutron capture, (E)
ALUMINUM, IRON, IRON-56, IRON-57, IRON-58, NICKEL, NICKEL-58, NICKEL-60, NICKEL-61, NICKEL-64, SODIUM—neutron capture by, resonances in epithermal and fast, (E)
BORON-10—neutron reactions (n,α) with, Doppler broadening of 478-keV lithium-7 gamma ray from thermal, (E)
LITHIUM-7—gamma spectra from boron-10 (n,α) reactions, Doppler broadening of 478-keV line in, (E)
GAMMA RADIATION—spectra of, computer program for analysis of
MESONS (π^+)—interactions $\pi^+ + n$ at 3.29 GeV/c, with 4π and 5π production, (E)
BARYONS, RESONANCE (N^*)—production in interactions $\pi^+ + n$ at 3.29 GeV/c, (E)
RADIATION DETECTORS, SEMICONDUCTOR (SILICON)—iodine-127 channeling in
IODINE-127—ion detection using silicon semiconductor detectors, channeling effects on
CHARGED PARTICLES—detection using silicon semiconductor detectors, channeling effects on
FISSION—lifetime measurements using blocking effects in single crystals
NUCLEI—fission of, lifetime measurements using blocking effects in single crystals
GERMANIUM-73—Moessbauer effect in chromium, measurement using Coulomb recoil implantation, (E)
GOLD-197—hyperfine structure coupling in intermetallic compound Au_2Mn, pressure dependence of, (E)
GOLD ALLOYS—Au–Mn, gold-197 hyperfine structure coupling in intermetallic compound Au_2Mn, pressure dependence of, (E)
COPPER ALLOYS—Au–Cu, gold-197 Moessbauer effect in, ordering effects on isomer shift of, (E)
GOLD-197—Moessbauer effect in copper–gold alloys, ordering effects on isomer shift of, (E)
KRYPTON—atomic transitions in, oscillator strengths for resonance, (E)
URANIUM—use of activated, as getter for vacuum systems
CARBON TETRAFLUORIDE—molecular motion in liquid and solid, rotational
MESIC MOLECULES—description using Born-Oppenheimer approximation with corrections for nonadiabaticity
HYDROGEN IONS—description of molecular, using Born–Oppenheimer approximation with corrections for nonadiabaticity
ELECTRON MICROSCOPY—use in identification of molecules
MOLECULES—identification using electron microscopy
ELECTRON MICROSCOPES—development of high-resolution
(D.C.W.)

31835 (ORNL-TM-1816) MONTE CARLO CALCULATIONS OF THE NEUTRON FLUX WITHIN A $^{10}B_4C$ SHELL. Freestone, R. M. Jr. (Oak Ridge National Lab., Tenn.). June 9, 1967. Contract W-7405-eng-26. 29p. Dep. CFSTI.

A Monte Carlo code, 05R, was used to study the transport of neutrons through a nearly spherical $^{10}B_4C$ shell. Such shells are often used to shield neutron detectors against the intense background of thermal neutrons associated with reactor or reactor-like neutron fluxes. An aluminum disk simulated a solid-state detector within the shell. Calculations were made for isotropic monoenergetic neutrons having energies of 0.5, 1, 2, 4, 6, 8, 10, 12, and 14 MeV, for an isotropic fission spectrum source, and, for comparison purposes, for a 4-MeV normal beam source. The results indicate that only a small distortion of the incident spectral shape is created by passage through the shell. The effect seems to be confined to incident neutron energies below 2 MeV. The degree of isotropy of the incident flux, however, importantly affects the absolute fraction of neutrons reaching the detector. (auth)

31836 (ORNL-TM-1867) A FORMALISM FOR THE CALCULATION OF NEUTRON-CAPTURE GAMMA-RAY SPECTRA. Yost, K. J. (Oak Ridge National Lab., Tenn.). June 9, 1967. Contract W-7405-eng-26. 25p. Dep. CFSTI.

A methodology for the calculation of neutron-capture gamma spectra in light ($A < 70$), magic, and near-magic nuclei was developed. Nuclear spin and parity effects relative to radiative transition probabilities are explicitly accounted for. Means are provided for allowing electric and magnetic dipole and quadrupole transitions, as well as spin-dependent spin-branching ratios. (auth)

31837 (RHEL/R-136) PLA PROGRESS REPORT, 1966. Batty, C. J.; Dickson, J. M. (eds.) (Rutherford High Energy Lab., Chilton (England)). Dec. 1966. 182p. Dep. CFSTI. HMSO 15s. 0d.

Separate abstracts were prepared for the eight sections of the report. (D.C.W.)

For abstracts of individual sections see: 30697, 31660–31663, 31710, 31737, and 31838.

31838 (RHEL/R-136, pp 89-130) THEORETICAL STUDIES. (Rutherford High Energy Lab., Chilton (England)).

Some studies of proton elastic scattering by C at 20 to 28 MeV, distorted-wave analysis of (p,n) cross sections, electron scattering by ^{16}O, phase-shift analysis of p-α scattering, single-particle excitations in ^{89}Y, alpha-particle scattering by ^{42}Ca and ^{50}Ti, analysis of (p,2p) reactions for information on nuclear structure, the (p,pd) reaction with antisymmetric wave functions, deuteron d-state effects in (d,p) reactions, the optical potential for 180-MeV protons, shell-model calculations for ^{42}Ca, single-particle wave functions for Ca isotopes, non-locality and spin-orbit effects in the shell-model potential, excitation of low-lying doublets in ^{16}O, and SU(3)-coupled wave functions for sd-shell nuclei are summarized. (D.C.W.)

31839 (YALE-1807-45) COMPARISON OF SEMICLASSICAL AND QUANTUM SCHEMATIC NUCLEON-TRANSFER MODELS. Breit, G.; Masso, J. F.; Polak, J. A.; Torchia, D. A. (Yale Univ., New Haven, Conn. Sloane Physics Lab.). June 16, 1967. Contract AT(30-1)-1807. 3p. (CONF-670910-1). Dep. CFSTI.

For Presentation at International Conference on Nuclear Structure, Tokyo, Japan.

The semiclassical and quantum–theoretical treatments of the interaction of two particles D (for donor) and A (for acceptor) with masses m_D and m_A with each other through a potential V_{DA} and with a particle n of mass m_n through δ-function potentials are compared. Poor agreement occurs at unrealistically small distances of closest approach. (D.C.W.)

31840 NEUTRON-CROSS-SECTIONS OF NUCLEI WITH CHEMICAL BINDING AT HIGHER ENERGIES. Drittler, K. Atomkernenergie, 12: 29-34(Jan.-Feb. 1967). (In German).

Using the formalism of Glauber and van Hove, a formula is derived from which the influence of chemical binding on neutron cross sections above 10 eV can be calculated. The results are discussed and compared with experiments. (tr-auth)

31841 INTRINSIC MOTION AND TRANSLATIONAL INVARIANCE IN SHELL-MODEL CALCULATIONS. Palumbo, F. (Centro di Studi Nucleari, Casaccia, Italy). Nucl. Phys., A99: 100-12 (1967).

The nuclear Hamiltonian has been replaced by another one which is identical with respect to the motion of the nucleons in their center-of-mass-system, i.e., to their intrinsic motion. The new Hamiltonian can be diagonalized in a shell-model basis without destroying translational invariance or giving rise to spurious effects due to the cms motion. This provides an alternative to the usual variational approach for handling very light nuclei provided difficulties arising from the hard core in the nucleon-nucleon potential are somehow circumvented. The method is extended to the nuclear Hamiltonian within the framework of the many-particle shell model, where corrective terms are found to arise when a nonlocal central potential is used. Finally the method is applied to the many-particle shell model in the Tamm-Dancoff approximation. Matrix elements of the terms, which take properly into account the cms motion, are found to be very important for 1^- states. It is shown in a quite general way that in the usual many-particle shell model, 1^-, $T = 1$ excited states approximately describe the intrinsic motions, while 1^-, $T = 0$ excited states are generally spurious. (auth)

31842 NEUTRON–PROTON INTERACTIONS IN ODD NUCLEI. Kim, C. H.; Pandya, S. P.; Wong, S. S. M. (Univ. of Rochester, N. Y.). Contract AT(30-1)-875. Nucl. Phys., A99: 161-9(1967). (UR-875-128).

The effective neutron-proton interaction, assumed to be central, is deduced for some nuclei in the region $A = 40$ to 90 from the spectra and other pertinent properties of doubly odd nuclei. A Gaussian-shape well with fixed range and exchange character parameterized in terms of V_0, V_σ, V_τ, and $V_{\sigma\tau}$ is used with an n-p wave function; and the values of the interaction strengths for best fit with data are calculated. It is found that the spin-independent parameters are relatively independent of the configuration and the parity of the Nordheim number, whereas the spin-dependent terms seem to have significantly different values for even and odd Nordheim number configurations. This may well represent the effects due to noncentral forces. (auth)

31843 NUMBER-CONSERVING APPROACH TO THE PAIRING-FORCE MODEL. II. COUPLED DEGENERATE MODEL. Hara, Kenji (Univ., Heidelberg). Z. Phys., 202: 504-13(1967).

The pairing-force model of finite spherical nuclei is studied in a way that does not violate the conservation of particle number. In the present model, the single-particle levels are first classified into two degenerate sets, and subsequently, the energy spacings in each set are taken into account by perturbation theory. Ground-state energies of the even nickel, tin, and lead isotopes are calculated and are found to be correct to within 300 keV by comparison with the exact solutions of the pairing hamiltonian obtained by Kerman, Lawson, and MacFarlane. (auth)

31844 DISSIPATION OF ENERGY AND ANGULAR MOMENTUM BY EMISSION OF NEUTRONS AND GAMMA RAYS. Grover, J. Robb (Brookhaven National Lab., Upton, N. Y.); Gilat, Jacob. Contract AT(30-2)-Gen-16. Phys. Rev., 157: 814-23(May 20, 1967). (BNL-10427).

Some of the consequences of the statistical theory of nuclear de-excitation for neutron and γ-ray emission from highly excited nuclei are examined. Special attention is given to the dissipation of angular momentum. To a first approximation, the nuclear "thermal energy" is removed first, initially by neutron and then by dipole γ-ray emission. The "rotational energy" is dissipated afterwards as a cascade of low-energy γ rays which may be composed of a high proportion of quadrupole radiation. The meager experimental data available are consistent with the theoretical expectations, but do not as yet permit a crucial test. Further possible experiments are pointed out. The role of the lowest-energy excited state at every angular momentum (yrast levels) is taken into account explicitly. The importance of using correct level densities at energies near the yrast levels, where the conventional level-density formulas may be very inaccurate, is stressed. (auth)

31845 NONLOCAL SHELL MODEL PARAMETERS FOR THE NUCLEAR GROUND STATE. Ulrici, Wolfgang Otto; Suessmann, Georg (Univ., Frankfurt am Main). Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 41: 183-8(Sept.-Oct. 1966).

An attempt was made to determine the ground-state parameters of a non-local shell model by fitting the binding energies of the protons and the charge radius of the nucleus, together with the mass defect. Calculated quantities are compared with experimental data for the nuclei ^{32}S, ^{40}Ca, ^{51}V, ^{59}Co, ^{115}In, ^{121}Sb, ^{123}Sb, ^{197}Au, and ^{209}Bi. (S.F.L.)

31846 BOSON-BROADENED PHOTONUCLEAR REACTIONS IN LIGHT NUCLEI. Duke, C. B. (General Electric Co., Schenectady, N. Y.); Malik, F. B.; Firk, F. W. K. Phys. Rev., 157: 879-84(May 20, 1967).

The giant dipole resonances in light nuclei are described by an intermediate-coupling model which attributes their fine structure and widths to the coupling between single-fermion states and collective bosons associated with the quasistationary stage of the reaction. This model can reproduce details in the giant resonances of ^{16}O and ^{28}Si, such as the over-all envelopes of the total width, the relative intensities of various major and minor peaks, and the widths of minor resonances. (auth)

31847 PHOTONUCLEAR EFFECT IN HEAVY DEFORMED NUCLEI. Arenhoevel, Hartmuth (Univ., Frankfurt am Main); Danos, Michael. Phys. Rev., 157: 1109-25(May 20, 1967).

The theory of Raman scattering is extended to include electric-quadrupole radiation. The results obtained are used to compute the elastic and Raman scattering cross sections of heavy deformed nuclei. The dipole and quadrupole resonances are described by a previously developed theory which includes surface vibrations and rotations. The computed cross sections are compared with experimental data for all those nuclei where both absorption and scattering cross sections are available. Some discrepancies still exist in certain details; however, the over-all agreement between theory and experiment is very good. (auth)

31848 GIANT RESONANCES AND NEUTRON-NUCLEUS TOTAL CROSS SECTIONS. McVoy, K. W. (Univ. of Wisconsin, Madison). Ann. Phys. (N.Y.), 43: 91-125(June 2, 1967).

Optical-model calculations of the total cross sections for neutron-nucleus scattering are examined in detail to determine whether Lane-Thomas-Wigner giant resonances in the strength functions ever cause corresponding maxima in the energy-dependence of the energy-averaged total cross sections. Although peaks of this nature do occur in certain partial-wave cross sections, non-resonant maxima of a completely different origin are present in other partial waves at nearby energies, so that the maxima observed in the total cross section are found to be complex superpositions of resonant and nonresonant single-particle effects. The nonresonant effect is dominant in the overwhelming majority of cases and causes the observed maxima to move to higher energy with increasing A for almost all elements. The principal exceptions occur at $A \approx 48$ and $A \approx 96$, where giant resonance peaks in the familiar $2d_{\frac{1}{2}}$ and $3p_{\frac{1}{2}}$ states may become large enough to visibly interrupt this trend. The energy dependence of the S-wave cross sections shows no resonance peaks whatever. (auth)

31849 DIRECT-COMPOUND INTERFERENCE AT AN ISOBARIC ANALOG RESONANCE IN DEUTERON STRIPPING. Hamburger, E. W. (Univ. of Pittsburgh). Phys. Rev. Lett., 19: 36-9(July 3, 1967).

Isobaric analog resonances are identified in the reaction $^{207}Pb(d,p)^{208}Pb$. A calculation of the cross section based on adding the scattering matrix elements for direct stripping (obtained from distorted-wave Born approximation) and for compound-nucleus formation (from R-matrix theory) fits the data near the $d_{\frac{5}{2}}$ resonance at 11.43 MeV well. (auth)

31850 TREATMENT OF NUCLEAR REACTIONS ABOVE THE TWO-PARTICLE THRESHOLD. Danos, Michael; Greiner, Walter (National Bureau of Standards, Washington, D. C.). Z. Phys., 202: 125-49(1967).

A formalism, exact in principle, is developed for describing nuclear reactions above the two-particle emission threshold. The eigenchannels, i.e., the eigenstates of the S-matrix, are computed directly from the shell model. No artificial assumptions have to be made about the properties of the rescattering of the two final-state particles; the final-state interactions are completely taken into account. Detailed prescriptions are given on how to reduce the exact description to a form amenable to numerical computations. Finally, long-lived intermediate states leading to the so-called sequential decays can, if so desired, be singled out and treated separately. This again involves no specific assumptions. The treatment is applicable also above the three- or more-particle threshold. (auth)

31851 SHELL MODEL APPROACH TO INTERMEDIATE RESONANCES. Brenig, W. (Max-Planck-Institut fuer Physik, Munich, Technische Hochschule, Munich). Z. Phys., 202: 340-8(1967).

Migdal's theory of nuclear structure is extended to treat the low-energy intermediate scattering resonances. It is shown that the position and width of resonances can be calculated using the same effective force as for the calculation of response functions and nuclear moments. (auth)

31852 A SHELL-MODEL CALCULATION IN THE CONTINUUM FOR THE REACTION $^{15}N(n,n')^{15}N$. Ebenhoeh, W.; Gloeckle, W.; Huefner, J.; Weidenmueller, H. A. (Univ., Heidelberg). Z. Phys., 202: 301-20(1967).

Using the shell-model approach to nuclear reactions, the Lippmann-Schwinger equation for elastic and inelastic nucleon scattering is solved numerically. The procedure is based upon an adaptation of a method due to Weinberg. The differential and total elastic and inelastic cross sections and the asymmetry of the scattering of a transversally polarized beam of neutrons are calculated. The positions (energies and total widths) and residues (partial widths) of the scattering matrix in the complex plane are determined. The results are discussed and are compared with previous treatments. (auth)

31853 SPLITTING-OFF OF THE CENTER-OF-MASS MOTION IN THE SHELL MODEL DESCRIPTION OF NUCLEAR REACTIONS. Wild, Wolfgang (Technische Hochschule, Munich). Z. Phys., 202: 220-35(1967). (In German).

The generalized Hartree-Fock method of Kerman and Klein is given in a modified version, which allows its application to the theory of nuclear reactions. It is possible to split off the effect of the center-of-mass motion rigorously. The remaining equations show a close analogy to those of the shell-model theory of nuclear reactions and can be treated by similar methods. (auth)

31854 INFLUENCE OF SHELL STRUCTURE AND MATRIX ELEMENT FLUCTUATIONS ON THE PAIRING CORRELATION IN NUCLEI. Rasmussen, J. O.; Ma, C. W. (Univ. of California, Berkeley). Z. Phys., 202: 182-9(1967). (UCB-34P141-5).

The uniform model for the nuclear pairing-force problem is extended to take into account the effect of fluctuations in nucleon orbital level density ρ and in pairing matrix elements $G_{\nu\nu'}$. Simple formulas for the average dependence of level density on energy are presented, and alternative ways of estimating effects of shell bunching on the pairing correlation are derived. It is argued also that the pairing constant G might be systematically overestimated in the usual BCS numerical calculations; a semi-constant pairing force with diagonal elements larger than off-diagonal is thus suggested. (auth)

31855 MICROSCOPIC DESCRIPTION OF COLLECTIVE NUCLEAR STATES. Amiet, J.-P. (Univ., Heidelberg). Z. Phys., 202: 150-76(1967). (In German).

The N-body nuclear problem is cast into a form which is appropriate for the study of collective states. Starting with the method of generator coordinates where the weight function is defined on a transformation group, the resulting integral equations are transformed into an equivalent set of partial differential equations. The role of the transformation group is to induce nuclear collective motions. The aim consists in extending the group-theoretical description of rotational states to other types of collective excitations. A subsequent transformation of the differential equations is performed. The resulting form is appropriate for the discussion of collective states in terms of particle-hole excitations. The possibility is investigated of introducing exact bosons in a microscopic way. (auth)

31856 ONE-DIMENSIONAL MODEL OF DEUTERON-POTENTIAL SCATTERING. Bierter, W. (Univ., Heidelberg); Dietrich, K. Z. Phys., 202: 74-88(1967).

A one-dimensional model of deuteron-potential scattering is considered as a simplified picture of a stripping process and is rigorously treated as a three-body system. (auth)

31857 COUPLING OF CORE EXCITATION AND SINGLE-PARTICLE MOTION IN ODD-A-NUCLEI. Beck, F.; Birkholz, J.; Manakos, P. (Technische Hochschule, Darmstadt, Ger.). Z. Phys., 202: 89-96(1967).

A physical fractional parentage expansion is presented which can be used to treat the coupling of single-particle and core motion in terms of the physical eigenstates of the core. The antisymmetry requirement is formulated in a subsidiary condition which allows diagonalization of the coupling Hamiltonian in the product space of the core and the extra-core particle. Restriction to a subset of core excitations leads to only approximate fulfillment of the subsidiary condition. The usefulness of the method is tested in the quasi-spin model. (auth)

31858 ISOSPIN PURITY OF THE ISOBARIC ANALOGUE RESONANCES FOR SEVERAL OPEN CHANNELS. Mahaux, C. (Univ., Heidelberg, Univ., Liege); Weidenmueller, Hans A. Z. Phys., 202: 97-108(1967).

The isospin purity of the full and of the doorway-state scattering functions in the internal region is investigated, under the assumption of no internal mixing. When several channels are open, it is shown that the isospin is pure at an energy $E_>$ (slightly larger than the resonance energy) only under a restrictive condition, namely that the reduced widths of the analog state vanish in all channels but one. This may happen either because of isospin selection rules (for the neutron channels) or for reasons of nuclear structure (for some of the proton channels). Then, the corresponding (p,n) and (p,p') cross sections vanish at $E_>$. If several channels with non-vanishing reduced widths are open, the isospin of both the full and doorway-state wave function is no longer pure at $E_>$. If two proton channels are open, the doorway state contains three different types of admixtures in the internal region. Two, one of isospin $T_>$ and one of isospin $T_<$, are excited according to a simple Breit–Wigner probability law. They are both independent of the entrance channel. The third one has isospin $T_<$, depends upon the entrance channel and is excited according to an asymmetric enhancement factor identical to Robson's. (auth)

31859 CORRECTIONS DUE TO HIGHER-ORDER ELECTROMAGNETIC TRANSITIONS IN NUCLEI. Eichler, J. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Z. Phys., 202: 49-57(1967).

Beta and gamma transitions via virtual intermediate states may give small corrections to various physical effects. Beta-gamma and gamma-gamma angular correlations may receive contributions which are not symmetric around ninety degrees. Gamma rays following beta decay may have a small circular polarization. All these effects seem to be too small to be measurable at present or to interfere with parity experiments. Corrections to the spectrum shape factor of first-forbidden beta decays are discussed in view of the ^{210}Bi (RaE) decay. (auth)

31860 SEMI-PHENOMENOLOGICAL NUCLEAR OPTICAL-MODEL POTENTIAL. Lipperheide, R. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Z. Phys., 202: 58-69(1967).

A semi-phenomenological form of the nuclear optical-model potential for the description of the average elastic scattering of nucleons is proposed. It consists of an energy-independent, non-local "single-particle" term and a sum of energy-dependent, factorable terms exhibiting "intermediate structure." (auth)

31861 SYMMETRY VIOLATING MODEL STATES AND COLLECTIVE MODES. Zeh, H. D. (Univ., Heidelberg). Z. Phys., 202: 38-48(1967). (In German).

A variational procedure is investigated which leads to solutions that can describe collective modes connected with symmetries of the Hamiltonian in a nonphenomenological way. Starting from a given set of trial wave functions $\{\phi\}$, all superpositions of the symmetry-transforms of any ϕ are permitted in addition. The trial wave functions ϕ and the weight functions of the superposition are varied simultaneously. The solutions are shown to be eigenfunctions of the symmetry operators. The weight functions are partly determined by group properties. In the case of one-dimensional representations, i.e., especially for Abelian symmetry groups, the superposition degenerates to become a projection. In the limit of a strongly symmetry-violating solution ϕ, the energy spectrum is also determined by group properties, and the weight function may be interpreted as the wave function of a collective motion. The equations of motion will then describe the interaction between collective and intrinsic modes. The nonaxial rotator is considered as an example. (auth)

31862 ON RULES OF E1 AND M1 TRANSITION INTENSITIES IN NUCLEI. Grin, Yu. T. (Kurchatov Atomic Energy Inst., Moscow). Phys. Lett., 24B: 605-6(June 12, 1967).

The dependence of E1 and M1 transition probability on spin levels up to the second-order terms due to the interaction of rotation and intrinsic motion is calculated. (auth)

31863 POLARIZATION IN "QUASIELASTIC" (p,n) REACTIONS AND A COMPLEX (t,T) TERM IN THE OPTICAL POTENTIAL. Friedman, E. (Hebrew Univ., Jerusalem). Phys. Lett., 24B: 607-9(June 12, 1967).

DWBA calculations of polarizations in "quasielastic" (p,n) reactions show sensitivity to a recently suggested imaginary part in the (t,T) term of the optical-model potential. (auth)

31864 SPIN ORBIT INTERACTION AND REGIONS OF DEFORMED NUCLEI. Bhatt, K. H. (Physical Research Lab., Ahmedabad, India); Parikh, J. C. Phys. Lett., 24B: 613-15 (June 12, 1967).

The role of the spin-orbit interaction in determining whether nuclei in a given region of a shell will be deformed or not is discussed. (auth)

31865 EXCHANGE EFFECTS IN ODD–ODD NUCLEI IN THE 2s–1d SHELL. Berrondo, M.; Pineda, J. (Univ. Nacional de Mexico, Mexico City). Rev. Mex. Fis., 16: 17-29(1967).

A model residual interaction consisting of a central long-range term plus a spin-orbit coupling term is considered, including an exchange force of the Rosenfeld type, and is applied to even parity states in the 2s – 1d shell in the supermultiplet classification, characterized further by $U_6 \supset SU_3 \supset R_3$, where only the highest irreducible representation of SU_3 is considered. Energy levels are obtained as functions of the parameter giving the relative strength of the spin-orbit coupling and the long-range term for ^{24}Na, ^{24}Al, ^{26}Na, ^{28}Al, ^{28}P, ^{30}Al, ^{32}Cl, ^{32}P, and ^{34}P. (auth)

31866 RELATIVISTIC ELECTRON SCATTERING IN A COULOMB FIELD. Fleischer, Jochem (Univ. Saarlandes, Saarbruecken, Ger.). Z. Phys., 203: 250-72(1967). (In German).

An approximative method for summing the partial-wave series for the scattering amplitude of the relativistic scattering of electrons by an atomic nucleus is investigated in the simplest case of a point charge nucleus for electron energies not less than 10 MeV. In the course of the computation, $\beta = 1$ is assumed ($\beta = v/c$; v and c denote the velocity of the electron and of light, respectively). The Sommerfeld-Watson-transformation is the starting point. The method consists in setting up an asymptotic expansion in $1/\sin^2(\Theta/2)$ (Θ is the scattering angle) of the amount coming from the Regge poles. Two further amounts, the dependence of which on the scattering angle especially for easy nuclei is little, are computed numerically without simplification, which should be possible. The method is developed from a special way of summing the partial-wave series for the nonrelativistic Rutherford scattering, which may be done analytically. Mott's scattering formula is verified, and finally the applicability of the method is examined for summing the relativistic partial-wave series with the exact S-matrix. The results are as exact as the expansion of the cross section to order $(Z/137)^5$ (Z is the nuclear charge). The method should in principle be applicable for an extended nucleus, but in this case there remain still several problems. (auth)

31867 CALCULATION OF THE AVERAGE ENERGY OF NUCLEAR MATTER WITH SEPARABLE INTERACTIONS. Oberlechner, G.; Trapp, G.; Yoccoz, J. (Centre de Recherches Nucleaires, Strasbourg). J. Phys. (Paris), 28: 277-80(Mar.-Apr. 1967). (In French).

Infinite nuclear matter calculations using the reaction matrix G of the Brueckner–Goldstone theory are simple in the case of a separable two-nucleon interaction. The latter is taken here to be Tabakin's potential and Hamman's separable potential, both of which reproduce the free two-nucleon scattering data up to 320 MeV. The results obtained for the computed average energy

per particle and the saturation density are discussed and are compared. (auth)

31868 DE-EXCITATION OF HIGHLY EXCITED NUCLEI. Grover, J. Robb (Brookhaven National Lab., Upton, N. Y.); Gilat, Jacob. Contract AT(30-2)-Gen-16. Phys. Rev., 157: 802-13(May 20, 1967). (BNL-10425).

A scheme of calculations useful for computer evaluation of the de-excitation of nuclei having large excitation energies and angular momenta is described. The scheme is based on the statistical model. Cascade emission of γ rays is taken into account. In particular, consideration of both dipole and quadrupole γ-ray emission, and of the crucial role played by the lowest excited state at every angular momentum in the nuclei involved are included. This places one, for example, in a position to study phenomena connected with particle emission following γ-ray emission. As input in a sample calculation ($Ce^{140} + O^{16}$ at 90 MeV, lab) information is used which was obtained from experimental data and from the optical and shell models, but is independent of the data with which comparisons are made. Generally reasonable agreement and no serious disagreements are found with a variety of experimental data, with no parameter adjustment. The predicted energy spectra of emitted α particles and γ rays show important features not demonstrated in previous, less complete calculations. The γ spectrum displays a low average energy of less than 1.0 MeV. The number of photons emitted by quadrupole radiation is typically of the same order of magnitude as the number emitted by dipole radiation. Other results are also described. (auth)

31869 EMISSION OF ALPHA PARTICLES FROM NUCLEI HAVING LARGE ANGULAR MOMENTA. Grover, J. Robb (Brookhaven National Lab., Upton, N. Y.); Gilat, Jacob. Contract AT(30-2)-Gen-16. Phys. Rev., 157: 823-31(May 20, 1967). (BNL-10426).

The statistical theory of nuclear de-excitation predicts α-particle energy spectra having important features that were missed in earlier, less complete calculations. To a good approximation, the α spectrum is composed of three qualitatively different subspectra. For ^{156}*Dy compound nuclei formed by $Ce^{140} + O^{16}$ at 90 MeV (lab), these subspectra have their respective maxima at 17, 12, and 7.5 MeV. The 7.5-MeV subspectrum should be resolvable into a group of sharp lines. The crucial roles of the lowest excited state at every angular momentum (the yrast levels), and of the competition with neutron and with dipole and quadrupole γ-ray emission, are stressed. Simple formulas are derived for estimating the energies at the maxima of the two lowest-energy subspectra. Since the α-particle subspectra are predictions of the most widely used version of the statistical model of nuclear de-excitation, a failure to observe them would be important. If they are observed, the experimental data should provide information about several nuclear properties heretofore inaccessible. (auth)

31870 SHELL-MODEL CALCULATIONS OF THE LOWEST-ENERGY NUCLEAR EXCITED STATES OF VERY HIGH ANGULAR MOMENTUM. Grover, J. Robb (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. Phys. Rev., 157: 832-47(May 20, 1967). (BNL-10428).

A combinatorial calculation is used to estimate the few (about ten) lowest-energy nuclear excited states at every angular momentum, out to very large angular momenta (e.g., out to about 70$\hbar$). It is useful to have these estimates to interpret many nuclear reactions, especially reactions induced by heavy ions and proceeding through the compound-nucleus mechanism. The calculation is based on a spherical shell model of fermions assumed to be noninteracting, except that pairing forces are taken into account. Several calculated examples are given. It is found that the division of nuclear excitation energy into "thermal" and "rotational" energies in computing level densities may not be very useful near to or far from closed shells, but may accidentally be useful for some intermediate cases. For convenience, however, the calculated levels can be thought of as embodying simultaneously the effects of pairing energy, rotational energy, and shell closure, which are often introduced separately and ad hoc into analyses of nuclear reaction data. The rate of increase of the nuclear level density at energies just above the lowest excited level at every angular momentum also depends sensitively on the proximity of the nucleus to closed shells. The "brute-force" calculation described here is only practicable if the energies of very many configurations can be computed and compared in a short time, a circumstance facilitated by use of a spherical model nuclear potential. However, it is found that an extension of this type of calculation to include nonspherical potentials should be feasible. Since, in discussing many nuclear reactions, it is necessary to call attention repeatedly to the lowest excited level at every angular momentum, it is desirable to give these levels a special name. It has been proposed that the lowest-energy excited state at a given angular momentum be called "yrast" level for that angular momentum. (auth)

31871 MORSE FUNCTION AND VELOCITY-DEPENDENT NUCLEAR POTENTIALS. Green, A. E. S.; Darewych, G.; Berezdivin, R. (Univ. of Florida, Gainesville). Phys. Rev., 157: 929-32(May 20, 1967).

Approximate analytic solutions and an eigenvalue formula are obtained for Schrödinger's equation with velocity-dependent potentials by using the well-known Morse function as an "effective" potential. The method is applied to neutron bound states in ^{17}O and ^{41}Ca and the results are compared with the numerical solutions of Wyatt, Wills, and Green, with recent experimental data, and with the results of a recent Hartree-Fock calculation. The method should be applicable to many nuclear problems in the mass range $10 \leq A \leq 50$ which require realistic nuclear wave functions, as well as to other problems in nuclear and particle physics. (auth)

31872 SIMPLE FORMULA FOR THE DRELL–WALECKA FORM FACTORS IN QUASI-ELASTIC ELECTRODYNAMIC PROCESSES. Henry, G. Reading (Harvard Univ., Cambridge, Mass.). Phys. Rev., 157: 871-3(May 20, 1967).

On the basis of a simple nuclear model, a covariant approximate analytic formula is given for the Drell-Walecka form factors $W_1(q^2, q \cdot P)$ and $W_2(q^2, q \cdot P)$. The formula applies in the region of q^2, $q \cdot P$ space corresponding to quasi-elastic scattering (defined here as elastic scattering from individual nucleons in the target nucleus). The approximation should be helpful in estimating experimental counting rates and backgrounds. (auth)

31873 INELASTIC ALPHA SCATTERING AND ASSOCIATED GAMMA RADIATION. III. Inglis, David R. (Argonne National Lab., Ill.). Phys. Rev., 157: 873-8(May 20, 1967).

In a 0-2-0 transition in a deformed nucleus excited by inelastic scattering of α particles, the pattern of γ radiation sometimes rotates rapidly backward as the α-particle scattering angle is increased. Previous papers employing a two-dimensional model have shown that this striking behavior may be attributed to the "beats" between incoming and outgoing waves at the edges of the nucleus. The most conspicuous effect there neglected was that of the "focus" of intensity of each of the distorted waves in the middle of its "shadow side" of the nucleus. Here it is shown that the influence of this effect modifies but need not destroy the reverse-rotation phenomenon, and that it provides an explanation for the failure of the reverse rotation to persist for small-angle scattering in most of the observations. (auth)

31874 COULOMB CORRECTIONS TO INELASTIC ELECTRON SCATTERING. Cutler, L. S. (Stanford Univ., Calif.). Phys. Rev., 157: 885-906(May 20, 1967).

The problem of making an improvement in the first-Born-approximation treatment of inelastic electron scattering involving Coulomb multipole transitions is approached by expressing the scattering cross section in terms of integrals over the nuclear-transition charge-density form factor with a kernel which contains all the electron physics. The distorted-wave Born approximation is used, and the interaction with the transverse electromagnetic field is neglected. Various approximations to the electron wave functions may be used to construct the kernel, leading to varying degrees of accuracy in the results. The kernel is computed in second Born approximation, using the radius approximation to allow for the finite nuclear size. An analytic expression is obtained for all multipole orders, and explicit results are given for the multipolarity J = 0, 1, and 2. Also an analytic expression for all multipole orders for the kernel in second Born approximation using the Yukawa static charge distribution is given. Integration of the radius approximation kernel with some simple transition form factors is carried out for J = 0,1, and 2 and analytic results are given. An application of these results for correction of nuclear transition rate estimates from electron-scattering data is presented. Analysis of the corrections in the limit of zero momentum transfer shows that the ratio of the cross section to the Mott cross section does not go to zero as (momentum transfer)^{2J} for J > 3 in second Born approximation. This is contrary to expectation. This work provides a simple means of getting some correction to the first Born approximation without the necessity of a digital computer. (auth)

31875 UNITARY MODELS OF NUCLEAR RESONANCE REACTIONS. Moldauer, P. A. (Argonne National Lab., Ill.). Phys. Rev., 157: 907-21(May 20, 1967).

While most reaction theories are formally flux conserving, the kinds of models and approximations used to specify the S matrix for resonance reaction processes are often of doubtful unitarity, particularly in the overlapping resonance region. To investigate the consequences of unitarity in this domain, several classes of simple analytically specified unitary S matrices are constructed by means of R-matrix models having various periodic arrangements of poles and residues. The resulting reaction amplitudes have a variety of fluctuating resonance spacings and widths as well

as nonresonant direct terms and up to three competing channels. Relationships between resonance parameters, channel transmission coefficients, average cross sections, and cross-section fluctuations are discussed. It is found that contrary to common belief unitarity imposes no restriction on the average ratio of channel width to resonance spacing. In all models investigated having no direct coupling between channels, the transmission coefficients are given by $T_c = 1 - \exp(-2\pi\bar{\Gamma}_c/D)$. Localized structure in the resonance parameters is investigated, and the effects of a single strong R-matrix pole are compared with those of a "giant-resonance" distribution of R-matrix pole strength. In this way, the shapes of both Robson's analog resonances and Feshbach's doorway state resonances are derived in a different dynamical context. Direct scattering and reaction amplitudes are found to be strongly correlated with resonance amplitudes. Thus, for example, two channels coupled by a direct reaction have correlated resonance width amplitudes, and the pole terms of the resonance reaction amplitude coupling them have a nonzero average. Evidence is found that unitarity imposes resonance-resonance correlations, and these in turn affect the relation between average resonance parameters and average cross sections and even more between these and cross-section fluctuations. (auth)

31876 DEUTERON STRIPPING ON A REALISTIC NUCLEUS. Kromminga, A. J.; Lim, K. L.; McCarthy, I. E. (Univ. of Oregon, Eugene). Phys. Rev., 157: 770-8(May 20, 1967).

A model for deuteron stripping is formally examined in which both neutron and proton can excite collective degrees of freedom of the target nucleus. A set of coupled equations is derived and is truncated by defining optical-model potentials. Appropriate optical-model potentials for computing are discussed and compared with potentials for related reactions such as proton elastic scattering. An expression for the stripping amplitude is derived in a weak-coupling limit. It describes all possible excitations in the model, not just the single-particle component of the final state as current stripping theory does. The purpose is to show what is involved in obtaining a realistic description of stripping and to make the approximations as explicit as possible. (auth)

31877 INTEGRAL EQUATIONS FOR DEUTERON-INDUCED NUCLEAR REACTIONS. Noble, Julian V. (Princeton Univ., N. J.). Phys. Rev., 157: 939-57(May 20, 1967). (PUC-937-232).

A new treatment of deuteron-induced nuclear reactions is presented. Uncoupled Fredholm integral equations for the reaction amplitudes are derived. Approximating the neutron-proton T matrix by a simple separable form gives the optical potential for deuterons, in terms of the neutron-target and proton-target interactions. All reaction amplitudes can be expressed, in this approximation, in terms of the off-shell (d,d') scattering matrix. For the special case of a spinless, inert, infinitely heavy target, the optical potential can be constructed by quadratures. This is done explicitly, and the numerical behavior of the partial-wave deuteron elastic-scattering equations is investigated for a simple model. Finally, the philosophy of this approach to the study of direct reactions is discussed, and extensions of the theory (for the treatment of local neutron-target and proton-target potentials) are suggested. (auth)

31878 STATISTICAL-THEORY CALCULATION OF CHARGE DISTRIBUTION IN FISSION. Wing, James (Argonne National Lab., Ill.); Fong, Peter. Phys. Rev., 157: 1038-43(May 20, 1967).

The nuclidic mass formula developed recently by the authors is employed to calculate the most probable charge Z_p of fission products. The predicted values of Z_p for thermal-neutron fission of ^{235}U and spontaneous fission of ^{252}Cf differ from the experimental values by a root-mean-square deviation of 0.35 and 0.55 charge unit, respectively, the computer calculation being made for charge values varying 0.05 charge unit at a time. These values may be compared with the root-mean-square deviations between two existing sets of experimental results on ^{235}U and on ^{252}Cf, which are 0.34 and 0.50, respectively. The root-mean-square deviations of the predicted Z_p values for many other schemes of charge division are calculated for comparison. The width of the charge-distribution curve of the primary fission fragments (before prompt neutron emission) in the peak-yield regions, calculated by the statistical theory (standard deviation of Gaussian $\sigma = 0.51$), agrees with the empirical value of Ferguson and Read ($\sigma = 0.55$) within 8%. Fine structure of Z_p due to the shell effect is noticed. (auth)

31879 WKB APPROXIMATION IN THREE DIMENSIONS. Van Horn, H. M.; Salpeter, E. E. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 157: 751-8(May 20, 1967).

An extension to three dimensions of the WKB approximation method for the quasiclassical wave function is discussed. The extended method is applicable to problems which possess an axis of symmetry but for which the potential need not be a separable function of the coordinates. The essential difference from the one-dimensional WKB approximation lies in the effect of the curvature of the wave fronts, which plays a central role in the three-dimensional case, and which has a direct physical interpretation. Formulas are derived for the wave function on the axis in both the allowed and the forbidden zones, as well as for the three-dimensional connection formulas. Application of the new method is made to the case of a pure Coulomb wave function and to the case of a particular nonseparable potential which is of interest in the theory of nuclear reaction rates at high density. (auth)

31880 PREDICTION OF THE α-PARTICLE SPECTRA OF TERNARY FISSION. Doan, Thu Phong; Carles, Claude; Chastel, Raymond (Faculte des Sciences, Bordeaux). Compt. Rend., Ser. A and B, 264: 900-3(Mar. 13, 1967). (In French).

By use of very simple considerations, the form of the energy spectra of α particles from ternary fission was predicted as a function of the angle of emission of the α particle with respect to the light fragment and as a function of the mass ratio. (tr-auth)

31881 SU(2), SU(3). PART III. SU(3). Gyoergyi, Geza (Central Inst. of Physical Research, Budapest). Fiz. Szemle, 17: 88-96(Mar. 1967). (In Hungarian).

In reviewing the SU(3) concept, it is pointed out, in analogy with the plane isotropic harmonic oscillator, that the invariance of the SU(3) Hamiltonian with respect to canonic transformations results in reaching an eigenstate belonging to the same energy eigenvalue, by using a special operator. The microscopic description of the rotational states of nuclei is considered within the framework of the Bohr-Mottelson phenomenological model. This Elliott model is especially well suited for light nuclei. Correlation of the plane isotropic harmonic oscillator with the SU(3) group lead Elliott to the development of a greatly idealized microscopic nuclear model containing rotational bands. The specific symmetry properties of the individual SU(3) multiplets are illustrated by means of Young's figures. Analysis of the states of the four external nucleons at the n = 1 level of ^{8}Be allowed the determination of SU(3) multiplets; the conclusions agreed with experimental findings. Gell-Mann and Ne'eman's eightfold classification makes use of SU(3) multiplets and generators. (TTT)

31882 ATOMIC DISPLACEMENT BY COULOMB SCATTERING OF PROTONS FROM 30 MeV TO 30 GeV ON NUCLEI OF Si AND Ge. de Lafond, Yann Gervais; Daspet, Danielle (Centre d'Etude Spatiale des Rayonnements, Toulouse). Compt. Rend., Ser. A and B, 264: 1083-6(Apr. 10, 1967). (In French).

The calculation of the density of atomic displacement by Coulomb scattering is successively made with the aid of various expressions of the differential cross section of proton-nucleus Coulomb scattering. This study makes it possible to define the role, in the theory of atomic displacement, of the approximation used in the establishment of the differential cross-section expressions. (tr-auth)

31883 PAIR PRODUCTION IN COLLISION OF A FAST PARTICLE WITH A NUCLEUS. Kel'ner, S. R. (Moscow Engineering-Physics Inst.). Yadern. Fiz., 5: 1092-1101(May 1967). (In Russian).

The expressions for the pair production cross section are obtained when the primary and secondary particles are relativistic. The relation between the contributions from different graphs are considered. (auth)

31884 COLLECTIVE EXCITATIONS OF WEAKLY DEFORMED NUCLEI. Rabotnov, N. S.; Seregin, A. A. Yadern. Fiz., 5: 996-1000(May 1967). (In Russian).

A simple universal relation between the exact value of the ratio $E_1(4^+)/E_1(2^+)$, energies of the other levels of rotational band and β-vibrational level 0^+ for the even-even axial nuclei is obtained, neglecting the effects of unharmonicity and the frequency shift of the zero-vibrations of nuclear surface due to interaction with rotation. It is of greatest interest to compare the obtained curves with the experimental data for 0^+ and 6^+ levels of weakly deformed nuclei where it is possible to follow theoretically the transition from the equidistant spectrum of spherical nuclei to the rotational spectrum of strongly deformed rigid nuclei. The calculated curves are in satisfactory agreement with the experimental data and allow the positions of the levels 0^+ and 6^+ to be predicted for the nuclei where these levels are unknown. (auth)

31885 RELATION BETWEEN THE MASSES OF NUCLEI. Osadchiev, V. M.; Troitskii, M. A. Yadern. Fiz., 5: 1001-7(May 1967). (In Russian).

The neutron (proton) binding energy is discussed in its dependence on the addition of two protons (neutrons). The change in the binding energy of an odd particle can be calculated in terms of the pole shift in one particle Green function. The calculations are considerably simplified when the total spin of two particles is

zero (i.e., the effective field affecting the odd particle is spherically symmetric). (auth)

31886 TOTAL NEUTRON CROSS SECTIONS OF ORIENTED NUCLEI. Inopin, E. V. Yadern. Fiz., 5: 1008-11(May 1967). (In Russian).

A simple formula for the total neutron cross sections of oriented nuclei is obtained on the basis of adiabatic approximation. The use of the black nucleus model makes it possible to compare the theoretical and experimental results for the interaction of neutrons with ^{165}Ho oriented nuclei. The fitting appears to be good for neutron energy E_n = 15 MeV. An essential departure from the experimental results for E_n = 8 MeV indicates that the black nucleus model is inapplicable at such nucleon energy. (auth)

31887 THEORY OF DIFFRACTION SCATTERING AND THE METHOD OF COMPLEX ANGULAR MOMENTA. Tishchenko, B. I.; Mel'nik, Yu. P. Yadern. Fiz., 5: 1012-20(May 1967). (In Russian).

Using the method of complex angular momenta, expressions are obtained for the cross sections of elastic and inelastic scattering of a particle on nuclei. The modulus and the phase of the scattering matrix are supposed to have poles in the complex l-plane in positions that do not coincide. It is shown that with this assumption a number of interesting properties of the cross sections can be explained, namely, the presence of very deep minima in cross sections, the different oscillation depth for the elastic and inelastic scattering, the scattering angle dependence of the oscillation period in the cross section, etc. A reasonable agreement with the experimental data on the scattering of α-particles on the ^{48}Ca and ^{88}Sr nuclei is obtained for a rather wide interval of the scattering angles. (auth)

31888 DIRECT EXCITATION OF NUCLEAR FISSION DEGREES OF FREEDOM AT LOW ENERGIES. Vorotnikov, P. E. Yadern. Fiz., 5: 1021-7(May 1967). (In Russian).

A comparison of fission widths Γ_f is carried out for the nuclear fission induced by γ rays, fast and slow neutrons. Γ_f is shown to depend strongly on the angular momentum transferred to the nucleus by the incident particle, while the angular momentum, parity, and internal structure of the target nucleus have a weak influence on Γ_f. It follows the conclusion about the direct excitation of fission degrees of freedom and about the connection between the symmetry character of the fissionable nucleus and the transferred angular momentum. The excitation exchange between one-particle and collective degrees of freedom seems to be a slow process as compared to the fission of an asymmetrical deformed nucleus. The height of the fission potential barrier exceeds essentially the value now accepted. (auth)

31889 NATURE OF ANALOG STATES IN HEAVY NUCLEI. Zaretskii, D. F.; Urin, M. G. (Moscow Engineering-Physics Inst.). Yadern. Fiz., 5: 983-7(May 1967). (In Russian).

The analog states in heavy nuclei are interpreted on the microscopic basis as collective excitations of the type proton-plus-neutron hole with total angular momentum equal to zero. The energies and the wave functions of the analog states as well as expressions for the excitation cross sections for these states are obtained in the framework of such an approach for the simplest nuclear reactions. (auth)

31890 E2-TRANSITIONS AND THE EFFECTIVE QUADRUPOLE CHARGE IN ODD NEAR-MAGIC NUCLEI. Kamerdzhiev, S. P. Yadern. Fiz., 5: 971-5(May 1967). (In Russian).

Probabilities of low-energy transitions and effective quadrupole charges for the nuclei with a nucleon beyond double-filled shells are calculated with the method of the finite Fermi system theory. Quadrupole moments of these nuclei are also calculated. The results are compared with the available experimental data. Taking the constants of the theory in accordance with the values given by other authors, a satisfactory agreement with the experiment is obtained. (auth)

31891 VOZBUZHDENNYE SOSTOYANIYA ATOMNYKH YADER. (Excited States of Atomic Nuclei). Davydov, A. S. Moscow, Atomizdat, 1967. 264p.

The basic phenomenological theory of excited states of atomic nuclei is explained. It was shown that the energy of excited states and probabilities of electromagnetic transitions in even-even, odd, and odd-odd nuclei are expressed through a small number of parameters characterizing the form of the nucleus in the ground state and its deformation. Questions on the classical low-energy excited states were investigated. The results of the calculations are given in the form of tables and graphs which are used during the comparison of theory with experimental data. (tr-auth)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 30437, 30505, 30540, 30593, 30598, 30610, 30706, 30980, 30989, 30997, 31001, 31794, and 32038.

31892 (ACNP–67520) PATHFINDER ATOMIC POWER PLANT. SHIELDING AND RADIATION SURVEY MEASUREMENTS (332). Lewellen, J. W.; Lacy, P. S.; Raby, T. M. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). June 1967. Contract AT(11-1)-589. 58p. Dep. CFSTI.

For Northern States Power Co., Minneapolis, Minn. and Central Utilities Atomic Power Associates.

The results of the shielding measurements and radiation surveys performed at the Pathfinder Power Plant during the reactor startup and power escalation programs are presented. Calibrated portable radiation survey meters including both neutron and gamma monitors and the installed nuclear and temperature instrumentation in the biological shield were utilized for these measurements. Radiation surveys were originally made at a nominal 6.5 Mw(thermal), and then repeated up to, and including, 90% full power. (M.L.S.)

31893 (AECL–2674) IRRADIATION BEHAVIOUR OF EXPERIMENTAL FUEL ASSEMBLIES OF UO_2–PuO_2 AND ThO_2–PuO_2. Jeffs, A. T. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Feb. 1967. 29p. (CONF-670306–4). Dep. CFSTI. CAN $1.00.

From IAEA Symposium on Uses of Plutonium as a Reactor Fuel, Brussels, Belgium.

The results are described of detailed examination of eleven Zr-2 clad oxide fuel elements after irradiation in NRX. Six elements were of UO_2-PuO_2 and these are compared with two enriched UO_2 elements after operation at heat ratings ($\int_{\theta_s}^{\theta_o}\lambda(\theta)d\theta$) up to 63 W cm^{-1} to an average burnup of 1550 MWd/Te oxide. The other three elements were ThO_2-PuO_2 containing up to 1.93 wt % PuO_2 and operating at ratings up to 77 W cm^{-1} ($\int_{\theta_s}^{\theta_o}\lambda(\theta)d\theta$) to a maximum burnup of 1260 MWd/Te oxide. The results reported comprise profilometer data, fission gas release, metallographic examination and autoradiography. (auth)

31894 (AECL–2693) BOUT: A PROGRAM FOR INTEGRATING THE BURNUP EQUATIONS FOR THORIUM AND URANIUM FUELS. Halsall, M. J. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Mar. 1967. 37p. Dep. CFSTI. CAN $1.00.

The computer code BOUT solves, by numerical integration, the chains of equations linking all important isotopes from ^{232}Th to ^{244}Cm. The equations which are solved and the method of calculating cross sections are given. The input and output of the program are described in detail and a complete listing of the code and library data is given, with annotation. A sample case with input data as punched on cards, and output exactly as produced by the computer is presented. (auth)

31895 (AECL–2863) HOW REACTOR DESIGN IS RELATED TO SITE APPROVAL AND CONTAINMENT IN CANADA. Hake, Guest (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Mar. 1967. 22p. (CONF-670402–2). Dep. CFSTI. CAN $0.50.

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna, Austria.

In Canada the statutory authority for the approval of reactors and their siting is vested in the Atomic Energy Control Board. The Board considers siting and containment in terms of the expected reliability of the reactor systems, and it considers the containment provision in terms of the effect upon the environment of a release of radioactivity. The safety assessments present the reactor design in three parts: the process systems which include the power regulating and the coolant systems; the protective systems; and the containment provision. The assessment considers the interrelationship of the reliabilities of these three parts. Designs of natural U heavy-water-moderated (CANDU) reactors can be developed that do not demand techniques and skills very much different from those found in other industries. Thus the reliability or availability requirements are by no means impossible to achieve. As confidence grows with accumulating experience, reliance on protective systems can be expected to reduce reliance on containment. A list of 24 references is included. (auth)

31896 (AECL–2865) FUEL BURNUP AND REACTIVITY CHANGES. Ward, A. G. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Mar. 1967. 16p. (CONF-670418–1). Dep. CFSTI. CAN $0.50.

From IAEA Meeting on Fuel Burnup Predictions in Thermal Reactors, Vienna, Austria.

The NPD reactor is operating with a natural-U fuel charge near equilibrium burnup for a bi-directional fuelling cycle. It is a well controlled critical experiment with irradiated fuel and gives a direct answer to the fuel burnup for this situation. It can be used as a reference experiment to normalize lattice codes, and only minor extrapolation is required to calculate burnup for larger reactors. Oxide samples from an irradiated NPD fuel bundle have been analyzed chemically for the Pu/U ratio, and mass spectrometric analyses were made of the Pu and U. The ^{235}U burnup agrees well with the predicted value; the Pu content and isotopic composition are compared with calculations on several computer programs. 17 references. (auth)

31897 (ANL–7294) TRANSIENT THERMAL STRESSES IN HEAT-GENERATING PLATES AND HOLLOW CYLINDERS CAUSED BY SUDDEN CHANGES IN ENVIRONMENTAL TEMPERATURE. Valentin, R. A.; Rosenberg, G. S.; Schoeberle, D. F. (Argonne National Lab., Ill.). Feb. 1967. Contract W-31-109-eng-38. 45p. Dep. CFSTI.

The transient thermal stresses in a free, heat-generating flat plate and a free, hollow, heat-generating cylinder, insulated at its outer surface and cooled on its inner surface through a temperature-independent boundary conductance, are analyzed within the framework of a quasi-static treatment to determine the effect of a sudden change in environmental temperature when combined with internal heat generation. The flat-plate problem is treated by Laplace transform methods, and the cylinder problem is analyzed by using a recently developed extension of the classical Hankel transform. Graphical temperature and stress results are presented for a wide range of Biot numbers and, in the case of the hollow cylinder, for a wide range of the thickness parameter. In addition, an extensive table of the characteristic roots occurring in the definition of the Hankel transform is included since these roots should find many applications beyond the particular cylinder problem considered. (auth)

31898 (ANL–7329) REACTOR DEVELOPMENT PROGRAM. Progress Report, April 1967. (Argonne National Lab., Ill.). June 16, 1967. Contract W-31-109-eng-38. 111p. Dep. CFSTI.

An operations history of the EBWR Pu Recycle is given. The sodium sampling program being conducted in the EBR-II is discussed. The zero-power and approach-to-power operation of the EBWR-II with stainless subassemblies, rather than depleted U, are described. Rod-drop data, showing a consistent prompt negative power coefficient, are discussed. The removal of blanket rods for dimensional and density measurements is discussed. Analyses of data from Assemblies 48 and 48A of ZPR-3 are tabulated. Assembly 49, a Pu core with well-degraded spectra, has been loaded into the ZPR-3. Construction progress on the ZPPR is outlined. Design work on the AARR is discussed. (M.L.S.)

31899 (BMI–1805) CALCULATIONS ON THE COLLISIONAL COALESCENCE OF FISSION-GAS BUBBLES IN SOLID FUELS. Baroody, Eugene M. (Battelle Memorial Inst., Columbus, Ohio). June 13, 1967. Contract W-7405-eng-92. 55p. Dep. CFSTI.

A largely analytical study is made of the collisional coalescence of spherical gas-filled pores similar to those involved in the swelling of nuclear fuel materials. The work is based on the integro-differential equation for the distribution in radius $\psi(r,t)$ and emphasizes problems for which similarity (or self-preserving) solutions can be obtained readily. For these cases ψ is a power of the time, t, multiplied by a function of a single variable $G(\eta)$, where $\eta = r\,t^{\beta}$. Physical assumptions are essentially the same as adopted by earlier workers, and major attention is given to situations where pore mobility results from surface diffusion. The time dependence of the pore density and of the moments $\langle r^n \rangle$ appears immediately, and convenient procedures lead, with little computation, to estimates of the magnitudes of the lower moments. The estimates are good, as comparisons with the numerical studies of Gruber show. Limited results are also obtained on how a simple initial distribution goes over quickly to the similarity form. A few results are given for related problems, such as the coagulation by Brownian motion of liquid droplets in colloidal suspension. It is pointed out that some problems of interest for pore coalescence appear not to lead to solutions of the similarity type. (auth)

31900 (BNL–998) SETTLED BED FAST REACTOR IN-PILE CAPSULE. Pancer, Guyon P.; Waide, Charles H. (Brookhaven National Lab., Upton, N. Y.). Aug. 1966. 20p. Dep. CFSTI.

A design for an in-pile capsule for irradiation of Settled Bed

Fast Reactor fuel is given. Consideration is given to both the ordered bed and the random packed bed concepts. Developmental irradiations were made in the Brookhaven Graphite Research Reactor and the Engineering Test Reactor. Descriptions of these capsules and of the in-pile tests are presented. (M.L.S.)

31901 (BNL-11463) LIGHT WATER MODERATED BREEDER. Manowitz, B. (Brookhaven National Lab., Upton, N. Y.). June 1967. 14p. (CONF-670602-14). Dep. CFSTI.

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif.

A concept for a light-water-moderated Th-^{233}U epithermal breeder reactor is presented. The core physics calculations are tabulated and discussed. A comparison between epithermal and fast breeders is given. Economic aspects of the epithermal breeder are considered. (M.L.S.)

31902 (BNWL-367) ENGINEERING DEVELOPMENT DEPARTMENT QUARTERLY REPORT, APRIL-JUNE 1966. Harty, H.; Batch, J. M.; Pedersen, L. T.; Wheeler, R. G.; Fox, J. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1967. Contract AT(45-1)-1830. 76p. Dep. CFSTI.

A discussion of cermet fuel analysis for the FFTF is presented. A feasibility study on gas cooling of fuel subassemblies is discussed. A synopsis of the survey of liquid metal test facilities is given. A brief summary of the nuclear electric plant capital costs vs. site location is presented. Calculational analysis of cross-flow mixing between flow channels during boiling is discussed. Neutron kinetics of coupled reactor theory are presented. Crack propagation test results on Zr 2.5% Nb pressure tubing are tabulated. A discussion of safety rod modification, oscillator development, and work done for the Phoenix fuel program in the HTLTR are discussed. Studies of radiation damage to reactor metals in the ATR gas loop are presented. The study of upstream boiling burnout is discussed. The heat transfer calculations for the FERTF fuel basket are discussed. Work done with the PRTR is summarized. Results of aerosol tests done in the Containment Systems Experiment are tabulated. The testing of small vessels is discussed. (M.L.S.)

31903 (BNWL-CC-500) AEC DIVISION OF REACTOR DEVELOPMENT AND TECHNOLOGY MONTHLY ACTIVITIES REPORT, JANUARY 1966. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 1966. Contract AT(45-1)-1830. 84p. Dep. CFSTI.

Work on the following subjects is outlined: civilian power reactors including specific fuel cycle analysis, conceptual reactor design studies, and the USAEC-AECL Cooperative Program; applied and reactor physics including Pu critical studies, high temperature reactor physics, and Phoenix fuel reactor program; reactor fuels and materials including fast fuels oxides and nitrides, swelling studies, nondestructive testing, nuclear ceramics, nuclear graphite, irradiation damage to reactor metals, ATR gas loop, and metallic fuels; engineering development including neutron flux monitoring, upstream boiling burnout, and microwave detection of coolant impurities; Pu recycle program including fuels development, fuels reprocessing development, physics, reactor engineering development, materials development, cycle analysis, critical facility operation, and test reactor operation; advanced systems including ^{233}U fueling of fast reactors; nuclear safety including containment systems R and D, pressure vessel crack monitoring, Columbia River sediment studies, radioactive shipment hazards, fission product aerosol containment, low and intermediate level waste studies, high level waste, gaseous effluent studies, and reactor safety analysis; HWOCR; and flux measurements. (M.L.S.)

31904 (BNWL-SA-1176) ANALYSIS OF A UO_2 19-ROD CLUSTER EXPERIMENT WITH THE RBU MONTE CARLO CODE. Thomsen, D. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 6, 1967. Contract AT(45-1)-1830. 14p. (CONF-670602-16). Dep. CFSTI.

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif.

The neutron flux distribution of a 19-rod urania cluster are calculated. The lattice constants for the cell, experimentally determined in the PCTR, are presented. Comparisons are made of the experimental and calculated values. (M.L.S.)

31905 (CEND-161) DESCRIPTION AND ANALYSIS OF CRITICAL EXPERIMENTS ON DOUBLE ANNULAR UO_2 FUEL ELEMENTS IN THE NUSU SUPERHEATER MOCKUP. Klann, P. G.; Dechand, C. O.; Fein, E.; Gormley, M. F. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). July 1962. Contract AT(11-1)-795. 62p. Dep. CFSTI.

The study previously made of double annular, UO_2 fuel elements in the uniform, clean lattices has now been extended to an actual mockup of the superheater zone of the design core in which water channels, control rods, and structural regions are incorporated into the lattice. A description of the experimental measurements made in this core as well as theoretical analyses comparing reactivity and power distribution calculations with experiment are presented. (auth)

31906 (CEND-284) METALLOGRAPHIC INVESTIGATIONS AND REPAIRS OF THE BONUS STEAM DRYER PREHEATER PIPING. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). [nd]. Contract AT(40-1)-2674. 135p. Dep. CFSTI.

The nondestructive tests, metallographic analyses, and repair work after cracks induced by stress corrosion were found in a portion of the dryer preheater piping of the Boiling Nuclear Superheater (BONUS) plant are described. It was concluded that the defects were largely caused by the high-temperature oxygenated steam environment. Both intergranular and, to a lesser degree, transgranular cracking were observed. In some instances the corrosion was aggravated by the presence of high-carbon stainless steel instead of the specified Type 304L. Repair of the piping system is described. (M.C.G.)

31907 (CONF-660904-Vol.1 and 2) PROCEEDINGS OF THE NINTH AEC AIR CLEANING CONFERENCE HELD IN BOSTON, MASSACHUSETTS, SEPTEMBER 13-16, 1966. Morgan, James M. Jr.; First, Melvin W. (eds.) (Harvard Univ., Boston, Mass. Harvard Air Cleaning Lab.). Jan. 1967. 1232p. Dep. CFSTI.

The use and effectiveness of high-efficiency air-cleaning systems for assuring reactor safety under normal operating and accident conditions are discussed. Phases of the air cleaning field examined include source term characterization, high-efficiency filter performance and evaluation, in-place testing, iodine removal, confinement and containment, incineration, noble gas studies, sodium and plutonium aerosols, and off-gas monitoring and analysis. Individual abstracts were prepared for 38 of the 54 papers presented. Sixteen papers were included in previous issues of NSA under the conference number CONF-660904. (H.D.R.)

For abstracts of individual papers see: 30493, 30494, 30558, 30574-30579, 30609, 30656, 30657, 30690, 30736, 30737, 31908-31928, 31995, 32009, and 32010.

31908 (CONF-660904-Vol.1 and 2, pp 4-27) ANALYTICAL DESCRIPTION OF THE DISTRIBUTION OF FISSION PRODUCTS DURING NUCLEAR REACTOR ACCIDENTS FOR WATER AND GAS COOLED REACTORS. Morrison, David L.; Gieseke, James A.; Ritzman, Robert L. (Battelle Memorial Inst., Columbus, Ohio).

A mathematical model has been developed to describe fission product release during water-reactor accidents. The input parameters for the equations for the release from the fuel are based upon experimental data, and the temperature input to the model is supplied from an independent heat transfer analysis. The transport and deposition of the fission products in the core and primary vessel are calculated to provide the source term for the transport and deposition analysis within the containment vessel. Two simple models, transport within a well-mixed gas or diffusion in a stagnant gas, are considered for this region. An analytical description of the time-space distribution of fission products in an accident can be obtained by the proper combination of these mathematical models. A list of 28 references is included. (auth)

31909 (CONF-660904-Vol.1 and 2, pp 28-48) CHARACTERIZATION OF SOURCE TERMS FOR AEROSOL TRANSPORT DURING SODIUM FIRES. Lauben, G. N.; Larson, C. L. (Atomics International, Canoga Park, Calif.).

The sources, consequences and radiological considerations resulting from a postulated spill in a reactor system are studied as they relate to aerosol transport. The heat and mass transfer processes and system variables are discussed. Analytical approaches are discussed with an example involving a semi-empirical accident model which includes gas buoyancy considerations. The current experimental systems and recent early results are described. (auth)

31910 (CONF-660904-Vol.1 and 2, pp 52-61) IN PILE STUDIES OF CONTAMINATION RELEASED IN CO_2 GAS COOLED REACTORS. Dadillon, J. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires).

Experiments have been made using an in-pile loop in which UO2 fuel elements with clad failure were irradiated. We were essentially interested in the I and its compounds. The filter packs used for sampling were composed of an asbestos paper, a knit-mesh (silver-plated copper wool), a charcoal-impregnated paper, five 1 cm thick charcoal beds and a final 5 cm charcoal bed maintained at temperature of -40°C. There were at least two iodine compounds in the loop with different behavior in charcoal; the efficiency of 5 cm charcoal for the compounds or the forms which have not been trapped by the impregnated paper or the knit-mesh

was about 99%; the charcoal impregnated paper trapped from 3 to 13% of the total activity; only about 1% of iodine generally remained in the knit-mesh. (auth)

31911 (CONF-660904–Vol.1 and 2, pp 75-6) SUGGESTIONS ON SPECIFICATION WRITING FOR ABSOLUTE FILTERS. Allan, A. R. Jr. (Flanders Filters, Inc., Riverhead, N. Y.).

The establishment of certain basic specification requirements is essential to the procurement of suitable high-efficiency particulate air filters with a minimum of difficulty and cost. Problems have been experienced in the manufacture and procurement of these filters because of inconsistent, ambiguous, and conflicting specification requirements as well as requirements that are not restrictive enough. The requirements for high-efficiency particulate air filters presented in this paper are intended to guide the specification writer toward standards that will produce uniformity in construction and testing practices to bring the cost of these units down to reasonable levels without sacrificing the necessary performance. A list of 20 references is given. (auth)

31912 (CONF-660904–Vol.1 and 2, pp 79-95) EFFECT OF SHOCK OVERPRESSURES ON HIGH EFFICIENCY FILTER UNITS. Anderson, W. L. (Naval Research Lab., Washington, D. C.); Anderson, T. (Naval Ordnance Lab., White Oak, Md.).

Overpressure shock resistance of the fire-resistant filter units in use in reactor systems today is compared to the shock resistance of the older combustible units. The filter unit shock studies are summarized. The effects of foam adhesives, dust loading, and wire cloth facing are discussed. (M.L.S.)

31913 (CONF-660904–Vol.1 and 2, pp 96-105) EFFECT OF FIRE INTRUSION AND HEAT ON HEPA FILTER UNITS. Murrow, Jack L. (California Univ., Livermore. Lawrence Radiation Lab.).

Special equipment has been developed for the dynamic testing of 1000-cfm high-efficiency particulate air filters by fire intrusion or high temperature. USNRL-type mechanical dioctyl phthalate generator and photometer systems are used to determine "before" and "after" filter efficiencies. The degree of protection of the HEPA filter from fire is almost directly related to the heat-absorbing capacity of the prefilter. Three new sealing materials have successfully passed hot gas tests. Particle board treated for fire retardance by the pressure-soak method has been accepted as framing material. Particle board having the fire-retardant material mixed in before pressing also shows promise as framing material, and is less expensive than particle board or plywood treated by soaking. (auth)

31914 (CONF-660904–Vol.1 and 2, pp 109-48) FACTORS INFLUENCING HIGH-EFFICIENCY GASKET LEAKAGE. Progress Report. Adley, F. E. (Hanford Occupational Health Foundation, Richland, Wash.).

Tests were performed to develop data which would demonstrate factors related to gasket leakage that warrant more detailed study. The effect of time on installed gaskets was shown by conducting tests to simulate and measure the effect of various mounting forces on leakage over a period of several weeks. The change in compression due to dynamic loading was demonstrated for a cellular and a solid gasket over a period of 20 days. Leakage from inadequately cemented gasket joints was significantly greater than from those well-prepared, but moderate clamping pressures reduced joint leakage, particularly with solid elastomers. High compression of the gaskets studied was found unnecessary to reduce leakage to levels well below the lower limit of sensitivity of the thermal dioctyl phthalate (DOP) filter testing method. Tests on solid molded gaskets of the same hardness in nine different shapes showed measurable differences in sealing quality although no particular configuration was a definite optimum. Gasket hardness failed to show any relationship to sealing quality nor was there any definite advantage between solid and cellular elastomers. (M.L.S.)

31915 (CONF-660904-Vol.1 and 2, pp 149-57) DEVELOPMENTS IN CONTAMINATED FILTER REMOVAL EQUIPMENT. Hahs, C. A. (Oak Ridge National Lab., Tenn.).

Equipment used to filter gases exhausted from a nuclear facility and the methods by which this equipment will be removed and replaced require careful planning. One filter removal carrier has been designed to remove filters from both the older and the newer filter pit installations and to provide γ and/or neutron shielding during this operation. Other developments in removal technique are exemplified by the methods used to remotely remove, transport, and deposit in-cell canister filters in disposable casks, and by the methods used to seal glove-box exhaust filters in their own polyethylene tubes before removing them. (auth)

31916 (CONF-660904–Vol.1 and 2, pp 199-229) RETENTION OF METHYL IODIDE BY IMPREGNATED CARBONS UNDER AMBIENT CONDITIONS. Parker, G. W.; Creek, G. E.; Ferreli, A. (Oak Ridge National Lab., Tenn.).

The effects of impregnating charcoal are discussed with reference to efficiency of methyl iodide removal from reactor containment systems. Performance tests on charcoals in the HFIR and LOFT are discussed. The effects of humidity on the filter efficiency are illustrated. (M.L.S.)

31917 (CONF-660904–Vol.1 and 2, pp 273-97) REMOVAL OF IODINE AND METHYL IODIDE BY AEROSOL FORMATION WITH HYDRAZINES. Viles, F. J. Jr.; Silverman, L. (Harvard Univ., Boston, Mass. Harvard Air Cleaning Lab.).

As an approach to handling radioiodine releases from nuclear installations, studies were made of the gas phase reactions of I_2 with hydrazine and with its unsymmetrical dimethyl derivative. These reactions lead to the formation of aerosols which could be effectively removed by filtration or by settling, diffusion and solubility processes. Hydrazine air concentrations of 765 to 890 ppM proved adequate for efficient aerosol formation and removal of both I_2 and methyl iodide. For dynamic conditions involving aerosol filtration, reaction times of several minutes were required. Reaction and natural aerosol removal processes under static conditions required several hours. Hydrazine concentrations of approximately 37 ppM were effective in removing methyl iodide only when alkali was present to remove the interference created by normal air concentrations of CO_2. Although tests were not made to determine CO_2 interference with the methyl iodide—unsymmetrical dimethyl hydrazine reaction at low concentrations, methyl iodide removal was complete with 90 to 180 ppM of this reactant in the absence of CO_2. Efficient aerosol formation and removal of I_2 by reaction with low hydrazine concentrations occurred in the presence of normal levels of CO_2. (auth)

31918 (CONF-660904–Vol.1 and 2, pp 371-88) FLOATING ROOF CONTAINMENT VESSELS. First, Melvin W.; Silverman, Leslie; Pender, Daniel; Dawson, Stanley (Harvard Univ., Boston, Mass. Harvard Air Cleaning Lab.).

Theoretical and experimental evaluations show that complete containment of the products of a nuclear reactor accident can be accomplished using a modified commercial gas holder. A holder capable of storing in excess of 20×10^6 cubic feet could retain such releases at a pressure substantially the same as ambient. As a first step in the evaluation of this concept, a small pre-pilot model was constructed to obtain information on seal mechanisms, lubricants, and functional parameters. Based on the resulting data, a 500 cubic foot floating type pilot-scale gas holder has been designed and is currently under construction. Advantages of the proposed system include its relatively low cost and the fact that the radioactive materials retained in the holder can later be removed by one or a combination of several decontamination methods. (auth)

31919 (CONF-660904–Vol.1 and 2, pp 419-52) AIR CLEANING FOR REACTORS WITH VENTED CONTAINMENT. Collins, R. D.; Hillary, J. J.; Taylor, J. C. (United Kingdom Atomic Energy Authority, Sellafield (England). Reactor Group).

A program of experimental work has been carried out under conditions appropriate to possible depressurization-type accidents to the Steam Generating Heavy Water Reactor (SGHW) at Winfrith Heath which has vented containment. The work has included small-scale experiments in glass or silica apparatus in which measurements have been made of the extent and form of the I_2 release from Zr-clad UO_2 into steam under melting conditions and at about 1000°C. A number of tests have been conducted with simulated forms of I_2 on two large-scale steel models of the reactor water lute steam suppression system. Tests have also been carried out on 1000 cfm filter units to develop droplet disentrainment devices. Work on the development of charcoals to deal with penetrating I (methyl iodide) under wet conditions is reported separately. (auth)

31920 (CONF-660904–Vol.1 and 2, pp 586-611) RECENT ADVANCES IN MONITORING OF RADIOACTIVE GASEOUS WASTES AT ORNL. Manneschmidt, J. F. (Oak Ridge National Lab., Tenn.).

Many activities at the Oak Ridge National Laboratory are concerned with the chemical processing of radioactive materials. Gaseous effluents from these operations are treated to remove dangerous contaminants prior to release to the atmosphere. Routine monitoring of such emissions was started in 1956 when manually operated particulate monitors were installed at each of three process stacks. Since that date, coverage has been extended to six stacks, the sample withdrawal system has been rebuilt, and the detection equipment has been added to and modernized. The intensive monitoring has led to process improvements which have reduced the environmental releases of radioactivity in the Laboratory's gaseous waste effluents by a factor of three since 1962. (auth)

31921 (CONF-660904–Vol.1 and 2, pp 626-45) EVALUATION OF THE EQUATION THAT GOVERNS THE COAGULATION OF AN AEROSOL. Spiegler, P.; Morgan, J. G.; Greenfield,

M. A.; Koontz, R. L. (Atomics International, Canoga Park, Calif.).

An IBM 7094 digital computer was used in solving the equation that describes in time the behavior of an aerosol. The topics investigated include coagulation of a heterogeneous aerosol, coagulation coupled with stirred settling, and an external source that continuously generates new particles. In some instances, approximations to the code results may be obtained, provided simplifying assumptions are made. The results indicate that the aerosol concentration is a more important parameter than the initial particle spectrum. (14 references). (auth)

31922 (CONF-660904–Vol.1 and 2, pp 848-59) STANDARDIZED GENERATION OF VAPOR-PRODUCED SODIUM AEROSOLS AND THEIR BEHAVIOR. Koontz, R. L.; Nelson, C. T.; Baurmash, L. (Atomics International, Canoga Park, Calif.).

A method for generating reproducible Na aerosols in gas media of known composition is required in order to establish growth phenomenon and measurement techniques for particulates produced from a Na fire following a primary-coolant spill in a Na cooled reactor. Na aerosols have been produced by reacting Na vapor in the presence of N_2 with various mixtures of N_2 and air. By suitable variation of the conditions of generation, the concentration and distribution of the aerosols produced have been studied. These distribution data are presented as measured by different sizing techniques, and are compared to those produced by liquid Na-air reaction. (auth)

31923 (CONF-660904–Vol.1 and 2, pp 860-76) TECHNIQUES FOR SAMPLING SODIUM SMOKE AND FISSION PRODUCTS. Nelson, C. T.; Baurmash, L.; Koontz, R. L. (Atomics International, Canoga Park, Calif.).

Various sampling techniques are described which allow one to characterize the aerosols produced from Na fires in a controlled environment test chamber. By using plating and fallout deposition samplers combined with Cascade impactors, electrostatic precipitators, and millipore air samplers, studies are made of the spatial and temporal behavior during the production, dispersion growth, and removal of the suspended particulates. The role of each sampling technique in verifying analytical models is discussed. (auth)

31924 (CONF-660904–Vol.1 and 2, pp 877-904) SODIUM AEROSOL AND ITS FILTRATION. Himot, P.; Viles, F. J. Jr.; Sullivan, J.; First, M. W. (Harvard School of Public Health, Boston, Mass.).

Accidental loss of coolant from a Na cooled nuclear reactor can result in rapid vaporization and burning of the metal to produce an airborne fume. Restrictions on the quantity discharged to the atmosphere require 99% removal to prevent a health hazard in the surrounding environment. In this study various configurations of graded, deep bed filters were tested to evaluate their application for controlling such fumes and to determine their maximum filter loading capacity. The pack included 2-inch-deep beds of stainless steel fiber media followed by 2-inch-deep beds of glass fiber media and a pleated absolute filter. With proper design and operation, it was shown that a total filter storage of approximately 0.75 pound of Na per square foot could be obtained with greater than 99% by weight of Na fume being retained in the deep bed filter pack. No I, as elemental I or NaI, penetrated the filter pack when the Na melt contained 3.5 ppM I as NaI. (auth)

31925 (CONF-660904–Vol.1 and 2, pp 979-1019) FILTER TESTING PROGRAM: ATOMIC ENERGY OF CANADA LIMITED, Panchuk, F.; Rachuk, W. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.).

The filter test rig and mobile equipment fabricated for laboratory and field use are described as are typical filter installations. The tests themselves are described and the results are summarized. Field tests have shown that the performance of the self-contained filters commonly in use has been excellent. However, with open faced filters, unless the installation was carefully designed and maintained, excessive penetration could occur. (auth)

31926 (CONF-660904–Vol.1 and 2, pp 974-6) CONTINUOUS SAMPLER–MONITOR FOR FISSION PRODUCTS IN CONTAMINATED ATMOSPHERES. Schindler, R. E. (Idaho Nuclear Corp., Idaho Falls).

The Continuous Sampler-Monitor is being developed for use in sampling fission product concentrations in the containment building atmosphere during the Loss of Fluid Test. A spray scrubber, placed in the containment atmosphere, washes nearly all of the I and other condensible fission products from a continuously drawn atmosphere sample leaving essentially only rare gas fission products in the gas stream. The gas and liquid streams then flow outside the containment building for separate monitoring of their gross γ activity. (auth)

31927 (CONF-660904–Vol.1 and 2, pp 1108-32) IN-PLACE IODINE REMOVAL EFFICIENCY TEST. Viles, F. J. Jr.; Silverman, L. (Harvard Univ., Boston, Mass. Harvard Air Cleaning Lab.).

The application of I_2 removal units in the ventilation systems for nuclear power reactors requires a sensitive means for periodic in-place testing of their performance. This study involved the application of I-127 as a tracer for such tests and the associated development of a sampling technique which assures its collection at 100% efficiency, and an ultra-sensitive analytical technique for its analysis. Investigations showed that 1 inch depth beds of 1 to 2 mm diameter clean electrolytic Cu beads provided collection efficiencies greater than 99% for air velocities up to 120 fpm and for I_2 loadings up to 0.1 milligram per sq. cm. of Cu surface. An analytical technique, based on the I catalytic reduction of Ce^{+4} ions, proved reliable and adaptable to in-place testing. The analytical procedure is accurate for amounts of iodine ranging from about 0.002 μg up to 0.12 μg (assuming a 5 ml test sample). (auth)

31928 (CONF-660904–Vol.1 and 2, pp 1169-74) COMPARATIVE ENVIRONMENTAL HAZARDS FROM A RELEASE OF METHYL IODIDE OR ELEMENTAL IODINE. Bunch, D. F. (Idaho Operations Office (AEC), Idaho Falls. Health and Safety Div.).

Serious concern has been expressed over the behavior of methyl iodide and the effect of its behavior on possible environmental hazards from a release of radioiodine to the atmosphere. In an attempt to determine the fate of radioiodine in the environment, a series of planned releases is in progress at the National Reactor Testing Station, known as the Controlled Environmental Radioiodine Tests. On the basis of 15 field releases and more than 40 laboratory experiments we have found there is no significant difference in the metabolism of methyl iodide (CH_3I) or elemental iodine (I_2) in cows or in humans. The only real factor of importance in assessing the consequences of a release is the difference in the deposition velocity of the two forms. The deposition velocity of CH_3I is about 0.05% that of I_2. Evaluations of test data indicate that it is unlikely that the consequences from a release of mixtures of I_2 and CH_3I to the environment would be appreciably different from predictions based on the behavior of I_2 alone. 6 references. (auth)

31929 (CVNA–273) STUDY OF PROPOSED CVTR OPERATION AT 100 MWF. Novendstern, E. H.; Jones, M. B. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). May 1967. Contract AT(30-1)-2289. 50p. Dep. CFSTI.

An analysis of the CVTR was performed to determine if the reactor could be operated at higher than design power output. The analysis results indicated that all plant systems would operate satisfactorily at 100 MWf (fission power rating); the superheater could operate at this power level with increased flow, but the degree of superheat would have to be reduced below the 65 MWf value. (M.L.S.)

31930 (CVNA–276) CAROLINAS VIRGINIA NUCLEAR POWER ASSOCIATES, INC. RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report, July–September 1966. (Westinghouse Electric Corp., Pittsburgh, Pa. Advanced Reactors Div.). Contract AT(30-1)-2289. 78p. Dep. CFSTI.

A summary of work done on the following subjects is presented: radiation analysis, CVTR post construction chemistry program, thermal and hydraulic core, plant nuclear evaluation, ultrasonic inspection of pressure tubes, metallurgical examination of irradiated CVTR pressure tubes, and the CVTR high-power high-burnup irradiation tests. (M.L.S.)

31931 (CVNA–290) CHEMICAL SHIM CONTROL OF CVTR. Sammarone, D. G.; Nath, R. J.; Barrow, W. E. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). June 1967. 45p. Dep. CFSTI.

The feasibility of operating the CVTR using chemical shim control is investigated. Included in the study was a review of chemical requirements associated with chemical shim operation, the design of a system capable of inserting and removing the chemical poison, and physics calculations aimed at determining reactivity effects, control rod worths and temperature coefficients. The results of the study indicate that chemical shim control of CVTR in the form of natural B as boric acid, injected into the moderator, is feasible. An injection and removal system could be fabricated and added to existing systems. Physics calculations show that about 10 ppM B would be required, while the chemistry investigation shows that use of B concentrations of this level are completely compatible with the system. (auth)

31932 (DLCS–5000167) QUARTERLY OPERATING REPORT [OF SHIPPINGPORT ATOMIC POWER STATION], FIRST QUARTER 1967. (Duquesne Light Co., Shippingport, Pa. Power Stations Dept.). Contract AT(11-1)-292. 23p. Dep. CFSTI.

An operations history of the Shippingport Pressurized-Water Reactor Core 2 is given. The chemistry of the reactor and turbine plants and radioactive waste disposal are discussed. The refueling program is outlined. (M.L.S.)

31933 (DLCS-5000466) QUARTERLY OPERATING REPORT [OF SHIPPINGPORT ATOMIC POWER STATION], FOURTH QUARTER, 1966. (Duquesne Light Co., Shippingport, Pa.). Contract AT(11-1)-292. 27p. Dep. CFSTI.

An operations summary of the Shippingport Reactor is given. The chemistry of the reactor plant is discussed; turbine plant inspection is outlined. The refueling program is presented. Each of the major components that were repaired is discussed briefly. The test program is discussed. (M.L.S.)

31934 (GEAP-5277) DEVELOPMENT PROGRAM ON THE GARIGLIANO NUCLEAR REACTOR. Quarterly Report Nos. 16 and 17. Howard, C. L. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jan. 3, 1967. Contract AT(04-3)-189. 34p. (EURAEC-1823). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Analysis of the stability tests was continued, and preliminary open and closed loop transfer function results are presented for each test condition. The effects of flow and inlet subcooling on reactor stability are shown. (auth)

31935 (GEAP-5282) PRESTRESSED CONCRETE PRESSURE VESSELS FOR BOILING WATER REACTORS. Quarterly Report No. 5, July–September 1966. (General Electric Co., San Jose, Calif. Advanced Products Operation). Oct. 1966. Contract AT(04-3)-189. 14p. (EURAEC-1746). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The feasibility of adapting the BWR system to service with a prestressed concrete pressure vessel is investigated. A reduced cost per unit volume of space within the vessel would result from installation of all primary coolant system components inside the vessel. The concrete walls would thus provide overall containment for all the systems as well as serve as a biological shield. Discussions of conceptual designs of both natural- and forced-circulation BWR systems with both spherical and cylindrical concrete vessel geometries are presented. Insulation development for the vessels is discussed. (M.L.S.)

31936 (GEAP-5431) POWER REACTOR HIGH PERFORMANCE UO_2 PROJECT. Progress Report No. 2, November 1–December 31, 1966. Lees, E. A. (General Electric Co., Pleasanton, Calif. Nuclear Technology Dept.). Feb. 1967. Contract AT(04-3)-189. 12p. (EURAEC-1824). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Design work for Zircaloy-2-clad UO_2 fuel rods was directed toward devising a method of compartmenting, or segmenting, a small number of rods to evaluate the effect of partitions in minimizing axial movement of the molten UO_2 during operation. It is planned to use W wafers at ~18-in. intervals. Heat transfer calculations indicated that a W wafer the same diameter as the fuel is not satisfactory because a large heat flux spike at the clad surface occurs at the position of the wafer. By reducing wafer diameter and placing it in a recessed pellet so that a rim of UO_2 of low thermal conductivity surrounds the wafer, the local heat flux at the clad surface is reduced to a value slightly less than either side of the wafer. A thickness of 0.060 in. was chosen as optimum. Temperature and void coefficients for the cold centermelt bundles were calculated. (M.C.G.)

31937 (IFA-FR-55) MATERIAL CALCULUS IN NUCLEAR REACTOR THEORY AND CALCULATIONS. [Bibliography]. Rosescu, Teodor (Academia R. P. R., Bucharest. Institutul de Fizica Atomica). 1966. 26p. Dep.

A bibliography is presented on the use of matrix calculus in reactor theory. 197 papers are listed; availabilities are given with each. (M.L.S.)

31938 (IN-1101) THORIUM-^{233}U SAMPLE DESIGN CALCULATIONS. Millsap, D. A. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). June 13, 1962. Contract AT(10-1)-205. 14p. Dep. CFSTI.

An experimental program was initiated to study the Th–^{233}U irradiation-decay cycle. Needed for this program is a series of samples suitable for irradiation in the MTR and measurement in the ARMF that can still accomplish the objectives of the program. In addition, in order to check experimental results with theoretical calculations it is desirable that there be some provision for flux monitoring. A brief consideration of program objectives indicated that the series of samples should span a range of enrichments of up to 2.5% and be capable of irradiation in effective fluxes of at least 1×10^{14} nv. For the sample of maximum enrichment it was estimated that a core weight of 75 g would give an appropriate response in the ARMF. Hydraulic and heat-transfer calculations showed that irradiation samples incorporating the above features and consisting of Zr-clad cylinders could be safely irradiated in the MTR. Although calculated wall temperatures were moderate for a wide range of possible sample dimensions it was decided that the best choice of dimensions was as follows: length of core, 4 in.; overall length of sample, about 5 in.; OD of sample, 1.0 in.; outer cladding thickness, 40 mils, inner cladding thickness, 20 mils. The outer cladding thickness is greater to allow for monitor wire grooves. (auth)

31939 (K-DP-2251) PROMPT NEUTRON DECAY CONSTANTS CALCULATED IN HIGHLY ENRICHED URANIUM METAL ASSEMBLIES. Morrison, G. W.; Knight, J. R.; Irving, D. C. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). [nd]. Contract W-7405-eng-26. 5p. (CONF-670602-15). Dep. CFSTI.

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif.

A method for optimizing cross section data for multigroup calculations of prompt neutron decay constants. Results of sample calculations are tabulated. (M.L.S.)

31940 (LA-3655) FUEL CYCLE COST IMPLICATIONS OF LIQUID PLUTONIUM REACTOR FUEL. Hannum, W. H. (comp.) (Los Alamos Scientific Lab., N. Mex.). Nov. 1966. Contract W-7405-eng-36. 108p. Dep. CFSTI.

Probable fuel cycle costs for a liquid Pu alloy fuel have been studied for a particular fast breeder reactor application. The fuel cycle costs for the liquid fuel are at least as attractive as those derived for the solid-fuel reference case, and additional studies have indicated areas in which the liquid fuel would have a definite fuel cycle cost advantage over solid fuels. (auth)

31941 (LA-3708(Pt.1)) ADVANCED REACTOR TECHNOLOGY (ART). Quarterly Status Report for Period Ending April 30, 1967. (Los Alamos Scientific Lab., N. Mex.). May 1967. Contract W-7405-eng-36. 18p. Dep. CFSTI.

The various systems of UHTREX are discussed. The cold flow tests on the coolant system are described. Check-out of the computer systems, and programs for use in operation are mentioned. Estimates of reactivity worths of fuel mass and poison additions are discussed. Calculations of UHTREX transient responses are described. Reactivity calculations are tabulated. Fuel particle self-shielding calculations are compared for various types of analyses. The fuel elements, and tests planned for these, are discussed. The development of the fission-couple thermopile device for use as a neutron flux monitor is discussed. A method for nondestructive activation analysis for O in Ge is presented. Tests on vertical heat pipe operations are discussed. (M.L.S.)

31942 (NP-16793) STUDIER OVER REAKTORPLACERING. (Studies of Reactor-Siting). Thykier-Nielsen, Soeren (Tekniske Hoejskole, Copenhagen (Denmark). Instituttet for Matematisk Statistik). 1966. 169p. (In Danish). Dep.

Thesis.

Siting of a nuclear power plant in a given area was investigated. The consequences of a major reactor accident were evaluated. The composition and distribution of the population in the area and the meteorological conditions were considered. After examining several aspects of the problem a couple of criteria functions were set up. In minimizing these functions, under certain restrictions it will be possible to find the optimal site for a reactor, in the sense that the risk to the population from a fission-product release is minimized. (DENM)

31943 (NP-16803) O.E.C.D. HALDEN REACTOR PROJECT. Seventh Annual Report, 1965/66. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). 165p. Dep.

The research program at the Halden Boiling Reactor is discussed. Various aspects of the program are detailed. These are: reactor statics including the burnup physics program, spectral indices measurements, isotopic analysis, experimental technique for gamma scanning burnup measurements, critical size measurements on the burned core, measurements of temperature coefficient of reactivity on the burned core, measurements of power void reactivity on the burned core, and theoretical development of burnup physics; reactor dynamics includes the hydrodynamics program, dynamic coupling experiments, void responses with different void gages, stability limits of IFA-14, boiling loop experiments, measurements of the overall reactor stability conditions with moderator cooling, and application of dynamic models; water chemistry includes distribution of released radioiodine after a fuel failure. The development phase includes description of test fuel assemblies, flow instabilities in forced circulation assemblies, burnout and stability tests with IFA-40, general in-core instrument

experience, development of burnout detectors, gamma and neutron thermometers and neutron detectors, throttle valve development, development of differential transformers, development of a transducer for fission gas pressure, development of turbine flow meters, and development of a multimixer. The operations phase includes operating statistics, heavy water states, improvements to bunker building, air monitoring system, failure of test fuel elements, testing of fuel elements for causing leakage, fission gas collection, reactor vessel, electrical equipment, and the D_2O recombiner system. The staff and administrative control are outlined. (M.L.S.)

31944 (NUMEC-3524-27) DEVELOPMENT AND TESTING OF PuO_2–UO_2 FAST REACTOR FUELS. Progress Report, July 1–September 30, 1966. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Apr. 1967. Contract AT(30-1)-3524. 32p. Dep. CFSTI.

The 41 fuel capsules scheduled for irradiation in EBR-II have been shipped for non-destructive tests. The nineteen (19) C series capsules were loaded into the reactor. The eleven (11) A and eleven (11) B series are still undergoing testing. The twenty (20) library sample fuel rods have been fabricated and tested and are stored. The metallography of the final compatibility samples has been completed. Powders of two compositions — UO_2–12.5 wt % PuO_2 and UO_2–20 wt % PuO_2 were mixed with 316L and Hastelloy X metal powders and sintered at 1250°C and 1350°C for 24 hours in an N_2–6 vol % H_2 atm. There was no indication of a reaction in any of the samples when viewed at 1000 X. There was evidence of metal melting in several samples. The thermal expansion by x-ray diffractometer of UO_2–12.5 and 20 wt % PuO_2 in various atmospheres has shown anomalous results. Data is presented and possible explanations for the anomaly are given. The results of the latest extrusion UO_2 runs utilizing carbowax and carbopol as binders and water and glycerin as plasticizers are given. Carbowax significantly increases the fired density. Material fired after drying in the revolving ceramic dryer has yielded the straightest material thus far sintered. Six inch sections had a maximum bow of 0.015 in. A literature survey of the analytical techniques utilized in the determination of oxygen-to-metal ratio in the UO_2, PuO_2 and their mixed oxides has been performed. For the reliability and rapidity required in our work, the thermogravimetric approach has been selected for development. The development work relating to the determination of impurities in mixed oxides by spectrography has commenced with the purification of Pu for use in the standard samples. (auth)

31945 (ORNL-4069) DEVELOPMENT OF A MODEL FOR COMPUTING ^{135}Xe MIGRATION IN THE MSRE. Kedl, R. J.; Houtzeel, A. (Oak Ridge National Lab., Tenn.). June 1967. Contract W-7405-eng-26. 78p. Dep. CFSTI.

The Molten Salt Reactor Experiment (MSRE) is a fluid-fueled reactor with a potential as a thermal breeder. Because of the importance of neutron economy to the breeder concept, it is necessary to know the dynamics of ^{135}Xe in the circulating-fuel system. There are several "sinks" where Xe may be deposited from the fuel, notably in the gas space of the pump bowl and in the voids of the unclad graphite of the reactor core. Since ^{135}Xe in the core impairs the neutron economy, it is important to understand the mass transfer mechanism involved and the parameters that may be varied to control it. A model for computing the migration of ^{135}Xe in the MSRE and with experiments conducted to establish the model is presented. A preoperational experiment was run in the MSRE with ^{85}Kr tracer, and many of the gas-transport constants were inferred from the results. Since physical measurements confirm that there are bubbles in the system, the conclusion is drawn that the computation model, the Kr experiment, and reactor operation agree. (auth)

31946 (ORNL-4072) FABRICATION OF REBUILT BONUS REACTOR SUPERHEATER FUEL ASSEMBLY. Slaughter, G. M.; Franco-Ferreira, E. A.; Kirstowsky, E. C.; Klindt, K. K.; Long, E. L. Jr.; Tolson, G. M. (Oak Ridge National Lab., Tenn.). June 1967. Contract W-7405-eng-26. 163p. Dep. CFSTI.

A superheater fuel assembly for the Boiling Nuclear Superheat (BONUS) Reactor that had been destructively dismantled for examination has been successfully rebuilt. The renovation of salvaged parts, the procurement of replacement parts, the fabrication of a new set of fuel rods, and final assembly into the rebuilt unit are described. Procedures developed and adopted for weld and braze qualification, process control, testing, and inspection to ensure product reliability are also covered. The original design of the Inconel-clad UO_2 fuel rods was modified to ease fabrication and upgrade service performance. In addition steps were taken to ensure a fine grain size in the Inconel 600 cladding tubing after brazing of spacers. The reconstruction of the unit was basically a rod-type fuel element fabrication operation. Thirty-two fuel rods were made and incorporated into the final assembly. Cracking in the weld regions resulted in leaks that rejected four rods. The findings of a metallographic examination of some of the cracked regions are discussed. (auth)

31947 (SWRI-1228-9-9) INSPECTION OF THE CONTROL ROD BLADES [OF THE] ELK RIVER POWER PLANT, APRIL 24–MAY 22, 1966. Wylie, Robert D. (Southwest Research Inst., San Antonio, Tex. Dept. of Materials Engineering). June 22, 1966. Contract AT(11-1)-1228. 33p. Dep. CFSTI.

The control rods of the Elk River Reactor were inspected. The inspection revealed evidence of cracks in two rods which were of sufficient magnitude to consider immediate replacement. Eleven of the thirteen rods had cracks in gussets which support a retrieval pin at the top of the rod. It is believed that these cracks were the result of handling and may have been present during the first inspection. The tensile strength of the B stainless steel dropped to a level lower than that previously observed and the ductility became less. (auth)

31948 (TID-23844) EXAMPLE OF TWO-REGION REACTOR STABILITY WITH DELAYED NEUTRONS. Hetrick, David L.; Schmidt, Theodore R. (Arizona Univ., Tucson. Dept. of Nuclear Engineering). [1966]. Contract AT(04-3)-670. 25p. Dep. CFSTI.

The linearized point-reactor model in the prompt-jump approximation is used with a simple two-region lumped-parameter model for heat transfer to analyze reactor stability. The effect of neglecting delayed neutrons is discussed, and an example is presented which shows that delayed neutrons can impair stability under certain conditions. Results are presented as stability regions in a parameter space of the two reactivity coefficients and as power-temperature phase-plane plots obtained with an analog computer. A wide range of stability is demonstrated for combinations of prompt-positive and delayed-negative reactivity feedback. (auth)

31949 (UJV-1724) VYVIN TEPLA V PALIVOVEM CLANKU POHLCOVANIM γ-ZARENI A STEPENIM RYCHLYMI NEUTRONY. METODIKA VYPOCTU POPIS PROGRAMU MC-GAMMA-1. (The Development of Heat in Fuel Elements by Absorbed γ-Radiation and by Fission With Fast Neutrons. Description of the MC-Gamma-1 Program). Jakab, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Dec. 1966. 23p. (In Czech). Dep.

A method of calculation of the spatial distribution of the heat sources in an infinite reactor lattice with uniform spacing is given. The Monte Carlo method is used for calculations. The sources of heat are: absorption of energy of γ-radiation and fast neutron fission. The method for γ-quanta is described in detail and the differences between the end-product of γ-quanta and neutrons are presented. It is assumed that the thermal neutron flux distribution is known. The program MC-GAMMA-1 for γ-quanta is described; the results of calculations for the fuel element ϕ 112 mm. of the reactor KS-150 are presented. On the basis of the results, the usefulness of the program is shown for a reactor of definite dimensions. (TTT)

31950 (WAPD-TM-635) THE MULTIMODE SYNTHESIS APPROXIMATION FOR SPACE–TIME REACTOR DYNAMICS: AN APPRAISAL OF FINITE DIFFERENCING METHODS. Clarke, W. G.; Margolis, S. G. (Bettis Atomic Power Lab., Pittsburgh, Pa.). May 1967. Contract AT(11-1)-Gen-14. 76p. Dep. CFSTI.

An appraisal of possible finite differencing methods for the multimode time synthesis approximation to space-time reactor kinetics with emphasis on accuracy, stability, computer economy, and programming simplicity is presented. A FORTRAN IV digital program for the CDC-6600, MUMKIN-2, was used to perform these numerical studies and is described. The program is used to solve the multimode kinetics equations in the absence of reactivity feedback for up to nine trial functions and six delayed neutron groups. The program description includes an example of how multimode kinetics parameters can be generated by arithmetical operations on the synthesis edits of an existing one dimensional neutron diffusion program for up to four energy groups and 100 mesh points. Special features of the program include an automated data link for computing the multimode kinetics parameters ρ, $\bar{\beta}$ and Λ and a technique to achieve time synthesis with discontinuous sets of trial functions. (auth)

31951 (ORNL-tr-1690) CONTAINERS OF THE G2 AND G3 REACTORS: PROTECTION OF PRESTRESSING CABLES. Poitevin, P. (Compagnie Industrielle de Travaux (Entreprises Schneider) S. A., Paris (France)). Translated for Oak Ridge National Lab., Tenn., from a report. 4p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

A description of the high-strength prestressing cables used in the Marcoule G-2 and G-3 reactors is given. The techniques used for the protection of these cables, since they are dismountable and replaceable, are detailed. (M.L.S.)

31952 (ORNL-tr-1691) PRESTRESSED CONCRETE CONTAINERS OF THE G2 AND G3 REACTORS. Poitevin, P. (Compagnie Industrielle de Travaux (Entreprises Schneider) S. A., Paris (France)). Translated for Oak Ridge National Lab., Tenn., from a report. 8p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

Complete descriptions of the prestressed concrete containment vessels for the G-2 and G-3 Marcoule reactors are presented. Methods used for fabrication of these containment vessels are described. (M.L.S.)

31953 FUEL ELEMENTS FOR INTEGRAL SUPERHEAT. Gibbons, J. F.; Dietrich, J. R. (Combustion Engineering, Inc., Windsor, Conn.). Nucl. Appl., 3: 343-52(June 1967).

Assessments of the economics of power generation using integral nuclear superheater fuel elements of the rod type are pessimistic at the present time. On the other hand, combination boiler-superheater fuel elements, if they can be shown to perform satisfactorily in a reactor, offer much greater promise of producing power from an integral superheat reactor at an attractive price. The characteristics required of an economic superheat fuel element, and the manner in which the novel type of element described herein intrinsically supplies those characteristics, are discussed together with the results of certain design analyses and out-of-pile experiments. (auth)

31954 EFFECTS OF ASSUMPTIONS ON FUTURE TRENDS. Hoffman, B. L. (Atomics International, Canoga Park, Calif.). Nucl. Appl., 3: 333(June 1967).

A brief discussion of the future trends in nuclear power generation is given. Tabulated results of characteristics of mixed nuclear economics is given. (M.L.S.)

31955 SITING CRITERIA: A NEW APPROACH. Farmer, F. R. (United Kingdom Atomic Energy Authority, Risley, Eng.). Atom, No. 128, 152-66(June 1967).

The following topics are discussed as criteria for site selection of nuclear power reactors: Introduction and the need for change; introduction to and example of the probability approach; reliability of protective system; reliability of power supplies; reliability of structures; a boundary line as a criterion; assessment of risks to people; and discussions and conclusions. Information is also included under the following headings: Population near sites close to built-up areas; calculation of thyroid dose to individuals and to population; risk to population and calculation of number of cases of thyroid cancer; calculation of risk at 1000 yds to individuals; range of validity of linear thyroid dose; and assumed response relations. (UK)

31956 SGHWR: STEAM TURBINE FOR THE 100 MW(e) PROTOTYPE. Harris, F. R. Nucl. Eng., 12: 440-3(June 1967).

The turbine described has inlet conditions of 900 psi and 279°C (dry saturated). An internal separator is incorporated between the HP and IP cylinders, and an external separator and reheater between the IP and LP. An outline is given of the design of the condensing and feed heating plant. (UK)

31957 ASYMPTOTIC STABILITY OF XENON- AND TEMPERATURE-CONTROLLED POINT REACTORS. Akcasu, A. Z.; Akhtar, P. (Brookhaven National Lab., Upton, N. Y.). J. Nucl. Energy, 21: 341-9(Apr. 1967). (BNL-10570).

The question of asymptotic stability in the large (A.S.L.) for point reactors with non-linear feedback is formulated in general terms. The results are applied to the study of Xe oscillations in the presence of temperature effects, and conditions for their A.S.L. are obtained. The region of A.S.L. in the plane of equilibrium flux vs. temperature coefficient is determined and compared to the region of linear stability previously obtained. A criterion for boundedness of the Xe oscillations in the absence of temperature effects is also given. (auth)

31958 NUCLEAR, THERMAL, AND HYDROELECTRIC POWER [IN ONTARIO AND QUEBEC]. Engineer, 223: 838-42 (June 9, 1967).

The electricity supply programme organized under the publicly owned bodies Ontario Hydro and Hydro-Quebec is summarized. A survey is presented of the primary power projects in the area. (UK)

31959 ON-LOAD FUELLING OF A WATER REACTOR. Busk, Nils-Eric; Gloersen, Ivar; Macsson, Ragnar (ASEA, Vasteras, Sweden). Elec. Rev., 180: 908-12(June 16, 1967).

The 200 MW(e) Marviken PHW plant, of which the fueling system is described, is due for commissioning in 1968. The gain in burnup obtained by continuous replacement and radial displacement of the fuel is discussed. Specific features of the design described include the refueling machine, water lock machine, transport machine, control and instrumentation, and the fuel handling sequence. Development work is outlined. (UK)

31960 NUCLEAR POWER. Penney, William. Atom, No. 128, 136-44(June 1967).

The Citrine Lecture for 1967, was presented on May 23rd 1967 to the British Electrical Power Convention, Eastbourne, under the following headings: The 1955 White Paper – The future: systems and devices under development ("topping-up" devices – thermionic and closed cycle MHD, HTR, SGHW, FBR) – Effect of ground rules and "conventional" technology – The world position – Permissive factors in nuclear power (health and safety, fuel resources and supplies, enriched uranium, plutonium). (UK)

31961 APPLICATION OF SLOWING DOWN KERNELS TO THERMAL NEUTRON DENSITY FLUCTUATIONS IN NUCLEAR REACTORS. Williams, M. M. R. (London Univ.). J. Nucl. Energy, 21: 321-40(Apr. 1967).

The backward equation for the space and energy-dependent probability generating function of the density fluctuations in a nuclear reactor has been reduced to a more tractable form by the application of a slowing down kernel technique. Simple working expressions were obtained for the variance, the correlation function and the power spectral density (P.S.D.) in terms of the infinite medium slowing down kernel. The method includes the effects of detectors, delayed neutrons and slowing down time. In addition, the frequency characteristics of the detection apparatus are accounted for. It is shown that the dominant break frequency of the fundamental mode component in the power spectral density is markedly dependent on the slowing down lengths of the delayed neutrons, a result that can lead to appreciable corrections to the experimentally calculated neutron lifetime in certain systems. A general formalism accounting for slowing down, delayed neutrons and detector geometry is developed, and is applied to detectors of various shapes. Marked differences in the P.S.D. are noted for the different detectors in an infinite medium; for the finite medium, however, the effect of detector geometry is not so important, and it is shown that, in certain circumstances, experiments can be analyzed according to the simple, infinite medium-infinite detector formula. (auth)

31962 BUCKLING MEASUREMENTS WITH A REDUCED NUMBER OF FUEL ELEMENTS. Casini, G.; Paillon, M. (EURATOM-CCR, Ispra, Italy). J. Nucl. Energy, 21: 7-15(Jan. 1967).

A theoretical analysis of buckling measurements by the progressive substitution technique on heavy-water lattices is presented. The experiments were carried out at Chalk River in 1965 in cooperation between AECL and Euratom. Natural UO_2 and carbide fuel elements cooled by heavy water and organics were investigated. Two methods of interpretation are compared: The different substitutions are used to determine, by an empirical adjustment, the buckling difference between the test and the reference lattice. Each substituted core is interpreted in a direct way, by adjusting the k_{inf} of the test zone. For both methods a two-neutron-group homogenized multi-region model was assumed. From the analysis of the results it appears that a good accuracy can be obtained even with a number of substituted rods less than twenty-five. (auth)

31963 CYLINDRICAL CELL APPROXIMATION IN THERMAL UTILIZATION. Zweifel, P. F.; Mannan, M. A. (Univ. of Michigan, Ann Arbor). J. Nucl. Energy, 21: 1-6(Jan. 1967).

In solving the neutron diffusion equation in one cell of an infinite lattice, a common procedure is to replace the rectangular (or hexagonal) cell with an equivalent cylindrical cell. In order to estimate the effect of this approximation a new method is presented in which the flux in the entire cell is expanded in a Fourier cosine series. The boundary conditions over the cell surface are satisfied exactly. Algebraic equations for the expansion coefficients of the flux are obtained, since the integrals over the cell can be made in closed form. It is found that truncation of the flux series after 10 terms gives good results. The method is thought to have more general application than to the actual problem treated here since such 'mixed geometry' problems frequently arise in reactor physics and in other areas. (auth)

31964 DIFFUSION OF PLUTONIUM AND FISSION PRODUCTS IN MAGNOX FUEL CANS. Gibbs, G. B. (Central Electricity Generating Board, Berkeley, Eng.). J. Nucl. Energy, 21: 171-81(Feb. 1967).

Theoretical expressions are derived for the quantities of Pu and fission products which may enter a Magnox can from a natural U fuel bar under typical reactor conditions. The subsequent diffusion of these elements through the can wall is analyzed in detail. It is shown that Zr55 cans are unable to prevent intolerable Pu diffusion at high temperatures, but that Al80 cans are probably satisfactory at all temperatures. The possible effect of dissolved fission products on the Magnox solidus temperature was also investigated. (auth)

31965 VALIDITY OF THE BUCKLING CONCEPT AND THE IMPORTANCE OF SPATIAL TRANSIENTS IN THE PULSED NEUTRON EXPERIMENT. Wood, J. (Univ. of Birmingham, Eng.); Williams, M. M. R. J. Nucl. Energy, 21: 113-30(Feb. 1967).

By solving numerically the exact integral transport equation for a pulsed slab of pure moderator, and the corresponding asymptotic equation, it was possible to relate uniquely the buckling of the system to its physical size. In addition, the spatial transients, excited by the boundary, are found to have a marked effect on the flux curvature. Criteria are given for various moderators which will enable the experimentalist to judge the importance of dropping points near the boundary of the system when attempting to fit a cosine to experimental data. It is found that two distinct regions exist in a pulsed system: an interior region, corresponding to the dominance of the asymptotic solution, where the neutron spectrum exhibits the well-known cooling effect, and a boundary, or "buffer" region, which has no simple relation with the diffusion cooling effect. The energy of neutrons in the buffer region is found to depend markedly on the variation of total cross section with energy, and can lead to either heating or cooling of the neutron spectrum, according to the moderator. (auth)

31966 PREDICTION OF DEPARTURE FROM NUCLEATE BOILING FOR AN AXIALLY NONUNIFORM HEAT FLUX DISTRIBUTION. Tong, L. S. (Westinghouse Electric Corp., Pittsburgh). J. Nucl. Energy, 21: 241-8(Mar. 1967).

An empirical correlation has been developed for predicting the 'departure from nucleate boiling' (DNB) using data for an axially non-uniform heat flux distribution. This correlation is recommended for use in predicting the DNB flux in a reactor design. Procedures have been formulated for predicting the local DNB flux and the DNB location for a non-uniform flux distribution. The predicted results were compared and agree closely with the existing non-uniform flux DNB data. (auth)

31967 HISTORY OF THE NORWAY–NETHERLANDS CO-OPERATION IN THE AREA OF NUCLEAR ENERGY. II. Goedkoop, J. A. Atoomenergie Haar Toepass., 9: 69-88(Apr. 1967). (In Dutch).

The Norway-Netherlands agreement of 1951 led to the construction of JEEP, the first reactor built in cooperation by the two countries. The establishment of JENER and the work performed in its first years are described. The design studies made on NUPOP (natural U-power-only pile) are briefly outlined. (J.S.R.)

31968 ACCELERATION OF COOLANTS IN NUCLEAR REACTORS. Scholz, Franz (Kernforschungsanlage, Juelich, Ger.). VDI (Ver. Deut. Ing.) Z., 109: 675-82(May 1967). (In German).

The general requirements of various types of coolants for water-cooled, gas-cooled, and liquid metal-cooled reactors are discussed. Advantages and disadvantages of each coolant are considered. The overall problems of circulation of reactor coolants are presented. (M.L.S.)

31969 IMPORTANCE OF THE COLD LIMIT OF THE STEAM PROCESS FOR NUCLEAR POWER PLANTS. Trenkler, Harro (Gewerkschaft Auguste Viktoria, Marl, Ger.). Brennstoff-Waerme-Kraft, 19: 266-9(May 1967). (In German).

A comparison of nuclear power plants with conventional power plants is made. Emphasis is placed on the coolant needs of fossil-fueled plants with those of steam-cooled nuclear plants. Economics of the two types are compared. (M.L.S.)

31970 FIRST FAST NEUTRON REACTORS AND THEIR TEACHINGS. Sorger, Michel. Sci. Progr.-Nature, No. 3384, 135-42(Apr. 1967). (In French).

A brief review is given of the characteristics of the fast reactors now in operation in the world. First the principal parameters of fast reactors are outlined. The reactors discussed are the EBR-1, EBR-2, EFFBR, LAMPRE, Dounreay Fast Reactor, and the Russian Breeder Reactor 5. (J.S.R.)

31971 UPRAVLENIE YADERNYMI ENERGETICHESKIMI USTANOVKAMI. VYPUSK I. (Control of Nuclear Power Plants. Issue I). Kuvshinnikov, B. A. (ed.). Moscow, Atomizdat, 1966. 133p.

A total of twelve papers are presented in the collection. Separate abstracts were prepared for eleven of the papers. The paper for which no abstract was prepared is concerned with processes involved in finishing n articles at three different operating places. (J.R.D.)

For abstracts of individual papers see: 31972–31982.

31972 REGULATION OF POWER OF THE IGR PULSED REACTOR. Lavrenikov, V. D. pp 5-35 of Upravlenie Yadernymi Energeticheskimi Ustanovkami. Kuvshinnikov, B. A. (ed.). Moscow, Atomizdat, 1966. (In Russian).

The dynamic characteristics and the control processes of the IGR pulsed reactor are described. The differential equations for the reactor power as functions of the powers of six individual neutron groups, the reactivity, the neutron lifetime, and the delayed-neutron damping constant were derived. The coefficient of the differential equations and the root locus of the transfer function of the reactor are calculated. In view of the complexity of the calculations of the transients, an MN-7 computer was used to simulate the kinetics of the reactor under different perturbations, to calculate the reactivity during the operation, to determine the adjustment of the automatic regulator and its behavior under different perturbations, to program the profile of the mechanism for the control rod servomechanism, and to serve as a power regulator in conjunction with the control-rod servomechanism. Formulas are derived for the initial change in reactivity, for the motion of the control rods, for the startup conditions and for the automatic power regulator. Certain advantages of the proposed regulation system, compared with the open type, are claimed. The first experiments using the computer in the control loop offered promising results. A control loop for the rods without the use of a prescribed profile is described. (ATD)

31973 CERTAIN PROBLEMS OF OPTIMAL CONTROL OF NUCLEAR REACTORS. Plyutinskii, V. I.; Kazachkov, V. I.; Vishnyakov, V. I. pp 36-48 of Upravlenie Yadernymi Energeticheskimi Ustanovkami. Kuvshinnikov, B. A. (ed.). Moscow, Atomizdat, 1966. (In Russian).

Methods of increasing control system reliability, by increase of the reliability of the elements, and the design of reliable systems made up of unreliable elements are described. A relay-input regulator whose output signal guarantees sufficient speed of the control process in the absence of self oscillations is used. Such a system is based on a six-group solution of the reactor neutron kinetics. Block diagrams of regulators for the neutron flux for the coolant temperature are presented in the single-channel and in the three-channel operating versions. A tentative reliability of approximately 0.93 can be attained for the three-channel regulator. Another advantage of the three-channel regulator is that faulty operation of individual channels can be readily detected. (ATD)

31974 DYNAMICS OF AN AUTOMATIC CONTROL SYSTEM FOR REACTOR POWER WITH A STEPPING MOTOR TO DRIVE THE CONTROL RODS. Emel'yanova, I. S.; Sergievskii, A. V. pp 49-59 of Upravlenie Yadernymi Energeticheskimi Ustanovkami. Kuvshinnikov, B. A. (ed.). Moscow, Atomizdat, 1966. (In Russian).

The dynamics of an automatic control system is investigated. The system is assumed to operate in a mode where constant power is maintained, and the analysis is based on the assumption of one equivalent group of delayed neutrons. The dynamics of the control rod is analyzed in phase space by the phase trajectory method. Such a system provides stable control of power and if the reactivity introduced by the control rod in each set is small; the system behaves similarly to that in which the control rods move continuously. The upper limit allowed for this reactivity step in order for the system to stay in service a long time is determined. (ATD)

31975 STABILITY CONDITIONS FOR A PULSED CONTROL SYSTEM FOR REGULATOR POWER. Kuvshinnikov, B. A.; Plekhanov, L. P. pp 60-4 of Upravlenie Yadernymi Energeticheskimi Ustanovkami. Kuvshinnikov, B. A. (ed.). Moscow, Atomizdat, 1966. (In Russian).

A simple single-loop system is described in which it is assumed that the modulator and the actuating mechanism of the power regulator have no time lag (motor is equipped with an efficient brake). The delayed neutrons are replaced by a single equivalent group. The pulse-width modulator is represented as a set of a single-pulse source with a transfer function such that the entire pulse-width modulator can be replaced by equivalent pulse-amplitude modulator. A simple formula, $K < 4\lambda/T\lambda + 2$, is derived for the gain of the system required to keep the system stable (T is the modulation period and λ is a combination of system constants). The formula shows that in the range of modulation periods which are most probable for systems of this type (1 to 10 sec), the system stability depends little on T. The relation can be used for a tentative choice of transfer coefficients of the elements contained in the control system. (ATD)

31976 INFLUENCE OF THE COOLANT FLOW ON THE TRANSIENT PROCESSES OCCURRING IN A NUCLEAR POWER INSTALLATION. Mitenkov, F. M.; Obukhov, P. I.; Danilovskii, V. S. pp 65-71 of Upravlenie Yadernymi Energeticheskimi Ustanovkami. Kuvshinnikov, B. A. (ed.). Moscow, Atomizdat, 1966. (In Russian).

The influence of coolant flow on the transient processes occur-

ring in a two-loop nuclear steam generator with a water-water non-boiling reactor, for the purpose of determining qualitative relations between the corresponding system parameters and the amount of flow of the liquid (other conditions being equal) is investigated. The response of the system to the nonstationary conditions determined are external cooling of the reactor while maintaining nominal circulation of the coolant in the first loop, operation of the emergency protection with simultaneous variation of the circulation of the coolant to ½ nominal, jump in reactivity during the self-regulation mode, and jumpwise increasing coolant circulation from ⅓ to nominal. Plots of the measured quantities, obtained by solving the system of equations under these conditions, using the EMU-10 analog computer, are presented. The plots show the nominal heating against nominal coolant flow, the power, average coolant temperature, reactor-outlet temperature, and reactivity against time for different rates of flow, the maximum deviation of the coolant temperature from nominal against the nominal flow, the power variation during self regulation at different rates of flow, and the maximum deviation of power against coolant flow. The differential equations have been solved with a computer. The results show that an increase in the regular flow increases the speed of reactor shutdown cooling, reduces the deviation of the temperature from nominal, reduces the transient times, and reduces the maximum power deviation. It follows from the results that the main parameters of a nuclear power system with water-water non-boiling reactor (deviations of the power and temperature under nonstationary conditions) and the required efficiency of the control units under emergency conditions depend significantly on the nominal flow of coolant in the reactor. (ATD)

31977 SELF OSCILLATIONS IN A NATURAL CIRCULATION LOOP DURING BOILING. Proshutinskii, A. P.; Shugam, R. A.; Shishov, V. P. pp 72-81 of Upravlenie Yadernymi Energeticheskimi Ustanovkami. Kuvshinnikov, B. A. (ed.). Moscow, Atomizdat, 1966. (In Russian).

The stability of a circulation loop was studied using self oscillations produced in two-phase systems under natural circulation, at pressures from atmospheric to 10 atm, and heat loads up to 800×10^3 kcal/m^{2}hr. Principal attention was paid to the influence of the underheating of the water below saturation at the output in the heated section and of the pressure in the loop on the self oscillations, on their amplitude, on their frequency, and on the stability. The experiments were carried out in an experimental stand designed to investigate the hydrodynamics of two-phase streams in channels of various configurations. The tests consisted essentially of filling the stand with feed water and heating it electrically at different rates and under various pressures to disclose the conditions under which self oscillations in the liquid circulation set in. At constant heating, self oscillations set in at a temperature differential (below saturation) of 4 to 5C, but at 10 atm the differential rose to 23 to 25°C, so that the pressure exerts a stabilizing influence. No oscillations were produced at heat fluxes in excess of 5.50×10^{13} kcal/m^{2}hr at 2.9 atm. Conclusive results on the stability could be obtained only at low pressures, but even these results display the most important factors that influence the occurrence of self oscillations in a loop with natural circulation, and are useful from the point of view of reactor safety. (ATD)

31978 INFLUENCE OF THE TEMPERATURE COEFFICIENT OF REACTIVITY ON THE CHARACTER OF THE TRANSIENT AND EMERGENCY MODES IN A NUCLEAR POWER STATION. Mitenkov, F. M.; Obukhov, P. I.; Danilovskii, V. S. pp 82-91 of Upravlenie Yadernymi Energeticheskimi Ustanovkami. Kuvshinnikov, B. A. (ed.). Moscow, Atomizdat, 1966. (In Russian).

Results of an investigation of the dependence of the transients on the negative temperature coefficient for a two-loop system with water-water heterogeneous reactor are presented. Mathematical models of the reactor and of the steam generator are presented and differential equations and their solution using an EMU-10 analog computer are given. The tests consisted of determining the response of the system to a jumplike increase in the coolant flow in the reactor, to operation of the scram rod with subsequent cooling down of the first loop, and operation of the scram rods with simultaneous decrease of the flow in the first loop. In all these tests, a numerical analysis was made of the influence of the temperature coefficient on the character of variation of the reactor power and on the coolant temperature under the transient and emergency conditions. The transient processes with and without self regulation are compared for different temperature coefficients of reactivity. The results point to the need for taking into account both the temperature coefficient and the concrete character of the emergency conditions that characterize the specific nuclear power installation. (ATD)

31979 NUMERICAL INTEGRATION OF THE EQUATIONS OF REACTOR DYNAMICS. Chelintsev, N. G. pp 92-5 of Upravlenie Yadernymi Energeticheskimi Ustanovkami. Kuvshinnikov, B. A. (ed.). Moscow, Atomizdat, 1966. (In Russian).

The equations integrated are of the form $dn/dt = \delta k - \beta/l\, n + \Sigma_{i=1}^{6} \lambda_i C_i + S$, $dc_i/dt = \beta_i/l\, n - \lambda_i C_i$, (n—neutron density, δk—reactivity, l—effective lifetime of prompt neutrons, β_i—fraction of delayed neutrons of group i; β—total fraction of delayed neutrons; c_i—concentration of i-th group delayed-neutron emitters, λ_i—decay constant of these emitters; S—source power per unit volume). The integration is based on a finite difference method and it is shown that under suitable simplifying assumptions, corresponding to the steady state, the method makes it possible to use finite differences which are 100 to 1,000 times larger than in the Adams method, at the same accuracy. An example is presented, in which the solution was obtained by 28 steps with accuracy of 1%, as against several thousand steps in the usual method. (ATD)

31980 COMPARATIVE ESTIMATE OF THE OPERATION OF A PULSED AND CURRENT MEASURING CHANNELS IN THE CONTROL AND PROTECTION SYSTEM OF A NUCLEAR REACTOR. Kazachkov, V. I. pp 96-105 of Upravlenie Yadernymi Energeticheskimi Ustanovkami. Kuvshinnikov, B. A. (ed.). Moscow, Atomizdat, 1966. (In Russian).

A comparison of the errors arising in commonly used neutron counters for reactors and due to γ radiation, statistical errors in measurement of small neutron flux levels, dynamic errors in measurement of low neutron fluxes, the operating range, and the complexity of electronic apparatus is presented. The current type (where the ionization chamber pulses are first integrated by a load resistance and then amplified and recorded) and the pulse type (where the pulses are amplified and counted) were considered. The comparison is based on a statistical analysis of the possible errors and on the presently attained maximum sensitivities of the two types of instruments. Pulsed apparatus, when used with a time constant of 5 sec, can measure a minimum of 1 neutron/cm^{2}sec. Current apparatus can be used during start up purposes with a range of more than six orders of magnitude, whereas pulsed apparatus can be used for automatic starting only within approximately four or five order of magnitude. An increase in the range of the measurement of current type apparatus is possible, although current leakage through the insulation limits this range slightly. Under real operating conditions the sensitivity of current apparatus is 10^5 neutrons/cm^{2}sec. Automatic start of the power reactor with the aid of current apparatus is safe in practice during the first two hours after the start, if the null neutron current is lower than 10^5 neutrons/cm^{2}sec. If compensation is provided for the γ quantum level, then current apparatus can be used for safe starting of a power reactor from a level of 100 to 1000 neutrons/cm^{2}sec. (ATD)

31981 LOGARITHMIC AMPLIFIER IN THE CONTROL SYSTEM OF A NUCLEAR REACTOR. Kazachkov, V. I.; Klokova, T. F. pp 106-15 of Upravlenie Yadernymi Energeticheskimi Ustanovkami. Kuvshinnikov, B. A. (ed.). Moscow, Atomizdat, 1966. (In Russian).

Certain characteristics of a triode logarithmic amplifier which is used extensively in devices for control, protection, and automatic starting of reactors are considered. Methods of determining such characteristics as the input resistance and the time constant of the input circuit are described, and the volt-ampere characteristic is presented for different resistances connected in parallel with its input. An analysis of the circuit operation shows that the input resistance of the logarithmic amplifier changes appreciably with the measured current. To eliminate errors due to the deformation of the logarithmic-amplifier characteristic at small input currents, it is necessary to apply an initial bias current at the input circuit. The statistical error of logarithmic amplifiers is independent of the measured current. The dynamic error of the logarithmic amplifier does depend on the measured current, the reactor period, or the input capacitance employed. (ATD)

31982 DIFFERENTIATING AMPLIFIER IN THE CONTROL SYSTEM OF A NUCLEAR REACTOR. Kazachkov, V. I. pp 116-29 of Upravlenie Yadernymi Energeticheskimi Ustanovkami. Kuvshinnikov, B. A. (ed.). Moscow, Atomizdat, 1966. (In Russian).

The requirements of a differentiating amplifier when used in different sections of the nuclear-reactor control system, such as the channel for measuring the reactor period, the channel for reactor protection, and in other parts of the system are described. Since such an amplifier must supply signals to indicating instruments, regulating devices, protective circuits, and signalization circuits, the requirements imposed on the various signals are analyzed. The nature of the optimal input signal that would provide the most suitable output signals is evaluated and the parameters of a suitable differentiating network are derived. A detailed description is presented of the differentiating amplifier used at medium and high values of neutron flux, with a signal received from a logarithmic amplifier. This amplifier can operate from differential amplifiers having a slope from 2 to 10 v/decade, and stays stable at 10 to 40°C. (ATD)

31983 POWER REACTOR TECHNOLOGY. Volume 9, Number 4. Dutton, James J.; Lennox, David H.; Brown, Karl K.; Croke, Edward J.; Gold, Raymond; Schmeh, Barbara A. (eds.). One of the Five Quarterly Technical Progress Reviews Published for the Division of Technical Information, USAEC. Argonne, Ill., Argonne National Lab., 1966. 65p. GPO $0.70 Domestic, $0.90 Foreign.

Reactor operations experience, development of new reactor concepts, heat transfer research, and energy conversion are discussed in seven separate articles. Separate abstracts are prepared for each of seven articles. (M.L.S.)

For abstracts of individual sections see: 30624, 31285, 31984, 31985, 32000, 32018, and 32019.

31984 LET'S APPLY OPTIMAL CONTROL THEORY AND NONLINEAR ANALYSIS. Mohler, Ronald (Univ. of New Mexico, Albuquerque). Power Reactor Technol., 9: 169-73 (Fall 1966).

The results of the application of optimal control and nonlinear analysis to reactors is discussed. Some of the easier reactor-control problems are considered. A contrast between the classical methods and the operations analysis methods of solution of reactor problems is given. (M.L.S.)

31985 NPD PERFORMANCE INDICATES MERIT OF ON-POWER REFUELING. Brown, Karl K. Power Reactor Technol., 9: 180-6(Fall 1966).

The results of operational experience with the Nuclear Power Demonstration reactor is given. The fuel scheduling and refueling of the on-line reactor is detailed. Advantages of this procedure are outlined. The experience obtained is discussed. (M.L.S.)

31986 FOURTH INTERNATIONAL CONFERENCE OF AICA [L'ASSOCIATION INTERNATIONALE POUR LE CALCUL ANALOGIQUE). BRIGHTON COLLEGE OF TECHNOLOGY [ENGLAND], 14 TO 18, SEPT. 1964. SUMMARIES OF PAPERS. London, British Computer Society, Finsbury Court.

Summaries are included on a space-time analog model for nuclear power reactor burn-up computation, iterative analog models for dynamic studies of nuclear power reactor cores, critical comparison of different analog models for nuclear fuel rods, a reactivity meter for use with Daphne reactor, analog-digital computer processing of data for noise analysis in nuclear reactor systems, description of AWRE hybrid data processing system and some applications, and the simulation of fluctuation and propagation in nuclear reactors on a hybrid computer. (UK)

31987 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Hawkins, Ronald James; Turner, Frederick Henry (to Babcock and Wilcox Ltd.). British Patent 1,072,512. June 21, 1967. Filed June 19, 1964.

A nuclear reactor with the heat exchange located between the core and the pressure vessel is described. The heat exchanger support is attached to the pressure vessel. (J.C.W.)

31988 IMPROVEMENTS IN AND RELATING TO THE CONTROLLING SYSTEMS FOR NUCLEAR REACTORS. (to Societe Anglo-Belge Vulcain). British Patent 1,073,557. June 28, 1967. Priority date Aug. 19, 1964, Luxemburg.

A method is described of actuating reactor control rods by means of pressure differences in the primary cooling circuit. Primary coolant flows through a branch of the main cooling channel which contains the control rod. A valve arrangement allows the coolant to move the control rod to the desired position. (J.R.D.)

31989 IMPROVEMENTS IN NUCLEAR REACTORS. (to Babcock and Wilcox Co.). British Patent 1,073,715. June 28, 1967. Priority date June 18, 1963, United States.

A reactor design is described in which liquid coolant and gaseous moderator flow through the core inside the pressure vessel in separate parallel tubes. Drawings and specifications are included. (J.R.D.)

31990 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. (to Gesellschaft fuer Kernforschung mbH). British Patent 1,071,982. June 14, 1967. Priority date Feb. 25, 1964, Germany.

A nuclear reactor with fuel elements suspended in the reactor from a supporting plate either individually or combined in a fuel element cluster is described. (J.C.W.)

31991 STEAM TURBINE PLANT INCLUDING A GAS-COOLED NUCLEAR REACTOR. Southwood, James Robert Mitchell (to The Nuclear Power Plant Co. Ltd and AEI–John Thompson Nuclear Energy Co. Ltd.). British Patent 1,071,893. June 14, 1967. Filed Mar. 19, 1965.

A steam turbine plant for use in association with a gas-cooled nuclear reactor is described. (J.C.W.)

31992 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Taylor, Peter Anthony; Hawkins, Ronald James (to Babcock and Wilcox Ltd.). British Patent 1,072,513. June 21, 1967. Filed July 2, 1964.

The heat exchange system in a nuclear reactor having the core and heat exchangers within the same pressure vessel is described. Each heat exchanger provides a secondary flow path for fluid to be heated and a primary flow path through which core coolant has been heated by its passage through the core flow as the heating fluid. (J.C.W.)

31993 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Antill, John Edward (to United Kingdom Atomic Energy Authority). British Patent 1,072,745. June 21, 1967. Filed Mar. 15, 1965.

Corrosion of fuel element sheaths and other components in a gas-cooled reactor is described. The coolant gas comprises CO_2 and a quantity of CO. The fuel elements are sheathed in Ni or a Ni–Cu alloy. (J.C.W.)

31994 NUCLEAR REACTOR. (to Nuclear Materials and Equipment Corp.). British Patent 1,072,339. June 14, 1967. Priority date Jan. 21, 1965, United States.

A nuclear reactor design of the converter type for supplying electric power plants is described. A reactor core having a long life comparable to the life of the power plant in which it is installed is described. Equations are included determining conversion ratios. (J.C.W.)

Marine and Portable Power Reactors

Refer also to abstract 31280.

31995 (CONF-660904–Vol.1 and 2, pp 1134-49) IN PLACE TESTING FOR IODINE REMOVAL EFFICIENCY USING AN ELECTRONIC DETECTOR. Thomson, W. G. (Todd Shipyards Corp., Galveston, Tex.); Grossman, R. E. (Atomic Energy Commission, Washington, D. C.).

Technical specifications of the N. S. Savannah require quarterly qualifications of the air cleaning systems for ability to remove I_2. Such required periodic testing can be accomplished at low cost using an electronic detector-recorder that is sensitive to elemental I_2 vapor concentrations of one part in a billion parts of air. This test method has proven satisfactory in maritime service aboard the N. S. Savannah although a careful laboratory type operating technique is required. The combination of equipment and operating technique has qualified the air cleaning system with good correlation to more expensive, tedious, and time consuming tests using ^{131}I. (auth)

Rocket and Space Reactors

Refer also to abstracts 30616, 30617, and 31001.

31996 (ANL–7207) PHYSICS MEASUREMENTS WITH MODIFIED DILUENT COMPOSITIONS IN TUNGSTEN-BASED, ALUMINUM-REFLECTED FAST REACTORS. Knapp, W. G.; Doerner, R. C. (Argonne National Lab., Ill.). Feb. 1967. Contract W-31-109-eng-38. 39p. Dep. CFSTI.

A typically W-diluted, nuclear-rocket, metal-fueled assembly composition was used as a reference for studies of other core diluent materials. In combination with W, the other core diluent materials are depleted U, W, W-Re, and graphite. The critical experiments performed with each assembly are discussed at length. The critical masses of the various ZPR-9 assemblies are tabulated. The H central worths in the W, W-Re, graphite, and a typical loading for a W rocket-reactor are listed. Results of kinetics measurements and reaction rate measurements are detailed for all assemblies. Reactivity worths of B in the reflector are tabulated. A complete listing of measured vs. calculated parameters for W-based Al-reflected ZPR-9 assemblies is included. (M.L.S.)

31997 (NASA-CR–72245) DEFINITION OF SPACECRAFT AND RADIATOR INTERRELATIONS FOR NUCLEAR RANKINE SYSTEMS. Cockfield, R. D. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). Jan. 26, 1967. Contract NASw-1449. 119p. (GE-ANSO–6300-166).

The interrelations of flat panel radiators and cone-cylinder radiators for nuclear spacecraft are examined in terms of radiating area capabilities, launch loads, and spacecraft integration. The results of a parametric analysis of nuclear shield weight for both the conical and flat panel radiators for unmanned spacecraft are given. Maximum launch load limits, acting at the payload interface, are determined as a function of radiator size and pay-

load weight. Structural capabilities of the launch vehicle determine radiating area limitations. The feasibility of using the upper stages for radiator area is considered. Effect of launch loads on optimization of radiator design is evaluated. (M.L.S.)

31998 (NASA-TN-D-4037) VOLTAGE DISTORTION EFFECTS OF SNAP-8 ALTERNATOR SPEED CONTROLLER AND ALTERNATOR PERFORMANCE RESULTS. Repas, David S.; Valgora, Martin E. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). June 1967. 35p. CFSTI.

The results of the SNAP-8 alternator tests are presented. This alternator is rated 80 kilovolt-amperes at a power factor range of 0.75 (lagging) to 1.0, 120/208 volts, 400 hertz, and 12,000 rpm. Loads corresponding to typical alternator power outputs were studied to determine the effect of the saturable-reactor–parasitic-load type of speed controller on the harmonics present in the alternator and load voltages. For certain loads, the alternator kilovolt-ampere rating was exceeded because of the reactive power required by the speed controller. The overload on the alternator can be as much as 13 kilovolt-amperes. Saturation curves were obtained and the alternator efficiency was determined by the method of separation of losses. Calculated efficiencies from the latter test were compared with data obtained from the alternator manufacturer. (auth)

31999 (ORNL-TM-1833) SUMMARY OF DESIGN AND TEST EXPERIENCE WITH CESIUM AND POTASSIUM COMPONENTS AND SYSTEMS FOR SPACE POWER PLANTS. Young, H. C.; Grindell, A. G. (Oak Ridge National Lab., Tenn.). June 1967. Contract W-7405-eng-26. 74p. Dep. CFSTI.

The information available on the design and development of components for Cs and K vapor cycle systems for space power plants was reviewed. An overall summary of the work done is presented, together with a brief résumé of each of the principal design studies and test systems. All of the published literature (314 references) found was included in a bibliography. (auth)

32000 COMPONENT DEVELOPMENT: KEY TO RANKINE-CYCLE SPACE APPLICATIONS. Croke, Edward J. Power Reactor Technol., 9: 194-213(Fall 1966).

Reviews of developments are presented on Hg Rankine systems for SNAP-2 and SNAP-8 and on organic Rankine-cycle systems. Rankine component technology development is also reviewed. (J.R.D.)

32001 ABSORPTION OF THERMAL RADIATION ON THE TRANSPARENT WALL OF A NUCLEAR LIGHT BULB ROCKET ENGINE. McLafferty, George H. (United Aircraft Research Labs., East Hartford, Conn.). J. Spacecraft Rockets, 4: 758-61(June 1967).

An analytical study was conducted to determine heat deposition rates in the transparent wall of a nuclear light bulb rocket engine. Such an engine is based on the transfer of energy by thermal radiation from gaseous nuclear fuel through a solid transparent wall to seeded hydrogen propellant. The analysis employs measured spectral absorption coefficients of fused silica, a possible wall material, with and without corrections for reactor-induced opacity in the walls. The calculations are carried out for a radiant energy spectrum approaching the walls equal to the blackbody spectrum at the edge-of-fuel temperature, and for a blackbody spectrum corrected for the effects of the addition of an oxygen seed to the transparent buffer gas located between the gaseous nuclear fuel and the transparent wall. Calculations are also made to determine the temperature differences across the transparent wall necessary to remove the energy deposited in the wall. The results of the calculations indicate that the addition of a small percent of oxygen seed will permit absorption of much of the ultraviolet energy that would otherwise be absorbed in the transparent wall, thereby permitting this energy to be convected away by the buffer gas rather than conducted through the relatively low-thermal-conductivity transparent wall. (auth)

Research and Test Reactors and Critical Assemblies

Refer also to abstracts 30706, 31113, 31681, and 31898.

32002 (AE-277) EPITHERMAL AND THERMAL SPECTRUM INDICES IN HEAVY WATER LATTICES. Sokolowski, Evelyn K.; Jonsson, Alf (Aktiebolaget Atomenergi, Stockholm (Sweden)). May 1967. 45p. Dep.

Spectral indices were measured by foil activation technique in a number of different D_2O-moderated lattices in the Swedish zero power reactor R-O and the pressurized exponential assembly TZ. In most cases the fuel was in the form of single rods, distributed uniformly in the lattice. Parameters in these cases were lattice pitch and fuel composition. A 31-rod cluster lattice was also investigated, with the moderator temperature varying up to 210°C. On the basis of these measurements, as well as measurements on cluster lattices, reported by other investigators, it was possible to derive simple correlations for the spectral indices, which seem to be of fairly general validity for D_2O lattices. The experimental results were also compared with calculations using the multigroup collision probability program FLEF. (auth)

32003 (AECL-2689) CANDU-BLW EXPERIMENTS IN ZED-2. PART II. BOOSTER ROD EXPERIMENTS. Kay, R. E. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Mar. 1967. 49p. Dep. CFSTI. CAN $1.50.

Experiments were performed in a simulated CANDU-BLW lattice in ZED-2 to determine the perturbing effect of a mockup BLW booster rod on the surrounding lattice, the neutron density distribution within the booster, and its reactivity effect. Experiments were performed with the booster vertical along the axis of the lattice, and horizontal across a dia of the lattice near the position of maximum axial flux. The maximum observed neutron density perturbation was ~+55% at a distance ~20 cm from the booster. Reactivity measurements in terms of changes in lattice critical height were made relative to a standard absorber. Simplified perturbation theory calculations were performed to compare with the measured relative reactivity effects. (auth)

32004 (AECL-2692) THE NRX REACTOR. A GENERAL DESCRIPTION. Manson, R. E.; Smyth, H. E. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Feb. 1967. 159p. (IOI-309). Dep. CFSTI. CAN $3.00.

NRX is a tank-type reactor using uranium oxide fuel with some rods enriched in ^{235}U. It is heavy water moderated, light water cooled, and graphite reflected. The description of the NRX Reactor is prepared for reactor safety reports. It includes general descriptions, illustrations, and basic data of the reactor structure, auxiliary cooling and protective systems, fuel and experimental facilities. (J.C.W.)

32005 (APED-5000-A(Vol.1)) FACILITY DESCRIPTION AND SAFETY ANALYSIS REPORT FOR THE GENERAL ELECTRIC TEST REACTOR. (General Electric Co., Pleasanton, Calif. Vallecitos Atomic Lab.). July 1965. 167p.

A general description of GETR is given. A detailed site description is presented. The administrative structure of the GETR is given. The reactor facility is described in detail. (M.L.S.)

32006 (BNWL-388) SHIELDING CALCULATIONS FOR CONCEPTUAL DESIGN OF FFTF SODIUM SYSTEMS. Bunch, W. L.; Shaver, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1967. Contract AT(45-1)-1830. 31p. Dep. CFSTI.

Calculations indicate that the Na coolant in the Fast Test Reactor will attain saturated specific activities of the order of 0.1 Ci/cm^3 of ^{24}Na and 30 μCi/cm^3 of ^{22}Na. About 400 g/cm^2 of shield material will be required to protect operating personnel from the γ associated with the ^{24}Na activity. Following decay of this isotope, about 100 g/cm^2 will provide adequate shielding. Fission products entering the Na as a result of fuel cladding failures are not expected to increase basic shield requirements for the Na systems, but will probably influence conceptual design of maintenance and handling techniques for the systems. (auth)

32007 (CEND-105(Suppl.2)) ADVANCED CRITICAL EXPERIMENT SAFEGUARDS REPORT. SUPPLEMENT NO. 2. NUSU PHASE B AND C. Harding, R. S.; Slater, M. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Mar. 17, 1960. Contract AT(11-1)-795. 95p. Dep. CFSTI.

The Phase B and C experiments of CEND–NUSU critical facility are described. The basic reactor safety problems involved are discussed. The hazard particular to these experiments is that of flooding and voiding of the steam annulus around the superheater fuel rods. This is detailed. (M.L.S.)

32008 (CEND-110) CEND CRITICAL FACILITIES SAFEGUARDS REPORT: BONUS CRITICAL EXPERIMENT. Knapp, R. W. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Oct. 29, 1960. Contract AT(11-1)-795. 73p. Dep. CFSTI.

A description of the CEND Critical Facilities is given. A site description and reactor facility description are presented. The operating procedures, philosophy, and rules are discussed. The reactor core is described; the experimental program is outlined. A hazards analysis is given; fuel storage and handling is briefly discussed. (M.L.S.)

32009 (CONF-660904-Vol.1 and 2, pp 942-64) ZPPR ROOF SAND FILTRATION OF URANIUM, PLUTONIUM, AND URANINE AEROSOLS. Cheever, C. L.; McFee, D. R.; Sedlet, J.; Duffy, T. L. (Argonne National Lab., Ill.).

The accident filtration system for the proposed Zero Power Plutonium Reactor consists of a sand and gravel roof followed by HEPA filters. Filtration efficiency tests were run with U, Pu, and uranine aerosols to predict the effectiveness of this system for containment of Pu fume. Penetration of U and Pu fumes through 30 inches of sand ranged from .0004 to .02%. With the backup HEPA filters the overall penetration of Pu fume from a reactor accident should not exceed .0001%. Results indicate that uranine aerosol will be satisfactory for in-place testing of the sand and gravel roof. (auth)

32010 (CONF-660904–Vol.1 and 2, pp 1063-8) IN-PLACE TESTING OF CHARCOAL FILTER BANKS AT AMES LABORATORY RESEARCH REACTOR (ALRR). Gukeisen, C. A.; Malaby, K. L. (Ames Lab., Iowa).

The air exhaust system at the ALRR is described. An experimental program was conducted to develop an appropriate in-place I test for the charcoal filter banks. Three techniques were tested; namely, spectrophotometric analysis, neutron activation, and I-131 tracer. Comparisons of the testing results and experience are enumerated with comments and recommendations. The neutron activation and the I-131 tracer techniques proved to be the most appropriate methods for in-place I testing of the ALRR charcoal filter banks. (auth)

32011 (DP–1077) FAILURE ANALYSES AND PROPERTIES OF SAFETY ROD GUIDE TUBES FROM THE HWCTR. Marshall, R. P.; Selby, C. L. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Apr. 1967. Contract AT(07-2)-1. 21p. Dep. CFSTI.

Four of the six safety rod guide tubes in the Heavy Water Components Test Reactor at the Savannah River Plant failed after operating ~6000 hours at 200°C; two tubes contained 2- to 3-inch longitudinal cracks, one contained a 30-inch crack, and one contained short cracks, a long crack, and a complete transverse fracture. During service, the six tubes each had experienced between 222 and 327 test drops of the safety rods at 22 to 260°C. The failures were caused by stress pulses generated in the tubes during hydraulic deceleration of the falling safety rods. The cracks were initiated by low-cycle fatigue, due to repeated drops at elevated temperatures, and were propagated by drops at low temperatures. Residual stresses and high H contents, both from fabrication and from high in-pile corrosion rates, were significant contributing factors. In-pile corrosion rates were three to ten times the rates that would be expected in autoclave tests at the same temperature. (auth)

32012 (IAEA–3998-17) PROGRESS REPORT OF NORA PROJECT, JANUARY 1–MARCH 31, 1967. (Institutt for Atomenergi, Kjeller (Norway)). Apr. 1967. 29p. (NC–88). Dep. CFSTI.

A brief accounting for reactor operation time for NORA is given. Research on reactor noise is considered in some detail. Pulsed source measurements, research on cell parameters, and work on grey control elements are outlined. The comparison of results of computer codes CRISP and K-7 THERMOS–BIGG II calculations and measurements in NORA are discussed. (M.L.S.)

32013 (NASA-TM-X-1393) DESIGN OF GAS-COOLED TEST LOOP FOR NASA PLUM BROOK REACTOR FACILITY. Diaguila, Anthony J.; Dallas, Thomas; Saltsman, James F.; Wenzler, Carl J.; McGill, Arthur A.; Springborn, Roy H. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). June 1967. 124p. CFSTI.

A description of the gas-cooled in-pile loop for the NASA Plum Brook Reactor is given. The loop has a main coolant system consisting of a closed pressurized He loop. The flow rate around the fast section is varied by a bypass flow system; maximum gas temperature in the test section is limited by the physical properties of the removable test section. Fission product release from experiments is prevented by double containment. The loop can be moved from the reactor to the hot lab. Heat transfer and gas dynamics measurements of fuel element specimen configurations can be recorded remotely to provide in-pile-irradiation information. (M.L.S.)

32014 (ORNL–4123) MSRE CONTROL ELEMENTS: MANUFACTURE, INSPECTION, DRAWINGS, AND SPECIFICATIONS. Tolson, G. M.; Taboada, A. (Oak Ridge National Lab., Tenn.). July 1967. Contract W-7405-eng-26. 53p. Dep. CFSTI.

The control elements for the Molten Salt Reactor are Gd_2O_3–Al_2O_3 bushings canned in Inconel. The report includes material selection and development of fabrication methods. The can was made from fully inspected Inconel closed by four TIG welds. The Gd_2O_3–Al_2O_3 bushings were made by conventional pressing and sintering methods after a special prereaction step was used. The bushings were given thermal shock tests, weighed, dimensionally inspected, and given a final visual inspection for chips or cracks. As-built drawings, specifications, and manufacturing procedures are included. By methods described in this report, 160 MSRE control rod elements were manufactured. (auth)

32015 (ORNL–TM–1895) HIGH FLUX ISOTOPE REACTOR QUARTERLY REPORT, JANUARY, FEBRUARY, AND MARCH OF 1967. McCord, R. V.; Corbett, B. L. (Oak Ridge National Lab., Tenn.). June 9, 1967. Contract W-7405-eng-26. 29p. Dep. CFSTI.

A summary of operations of the HFIR is given. The special testing program is discussed. The tests include control-plate guide bearings, depleted fuel element shipping cask, hydraulic rabbit tube, target rod rupture, xenon transients, and water systems. (M.L.S.)

32016 (SC–RR–66–2643) CORE CALCULATIONS FOR SANDIA PULSE REACTOR II (SPR II). Schmidt, W. H. (Sandia Corp., Albuquerque, N. Mex.). May 1967. Contract AT(29-1)-789. 31p. Dep. CFSTI.

A summary of results and calculation methods, as well as justification for design criteria, is presented for the Sandia Pulse Reactor II (SPR II). Two-dimensional multigroup neutron transport theory calculations were made with the LASL DDK computer program. The results include core size, reactivity worths of core components, and temperature and neutron flux profiles. (auth)

32017 (UCID–4135) CORROSION OF GRAPHITE BY NITROGEN: A SUMMARY OF BLOWPIPE DATA. Rover Technical Note No. 205. Maimoni, A. (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 10, 1958. Contract W-7405-eng-48. 16p. DTIE.

The results of the N_2 corrosion runs are summarized. The weight losses, obtained by integration of the corrosion profiles of the inside of the tubes, were correlated with the O_2 content of the gas and with inside tube wall temperature. (auth)

32018 NEW DEPARTURES IN HIGH-FLUX RESEARCH REACTORS. Spinrad, Bernard I. Power Reactor Technol., 9: 153-61(Fall 1966).

A discussion of high-flux research reactors is given. The advantages of using flux traps are evaluated. Consideration is given to the compact reactor systems that are proton-moderated fast and thermal reactors. Small core water and heavy-water moderated reactors are discussed; small fast reactors and cavity and thin-shelled reactors are discussed. (M.L.S.)

32019 ZONE-LOADED CRITICAL EXPERIMENTS FOR FAST BREEDERS. Fischer, George J.; Travelli, Armando; Meneley, Daniel A. Power Reactor Technol., 9: 162-8(Fall 1966).

The role of zone-loaded critical experiments in predicting and checking basic physics parameters for fast breeders is discussed. The advantages of using zone-loaded experiments are presented. The usefulness of zone-loaded experiments in measuring neutron spectra, sodium void effects, Doppler effects, and reactor kinetics are briefly discussed. The limitations of the use of zone-loading is evaluated; safety aspects are considered. (M.L.S.)

32020 TRANSURANIC ELEMENTS AND THE HIGH-FLUX ISOTOPE REACTOR. Weinberg, Alvin (Oak Ridge National Lab., Tenn.). Phys. Today, 20: No. 6, 23-30(June 1967).

A description of the HFIR is given. Its use in production of transuranic elements, particularly ^{252}Cf, is discussed. Research efforts on transuranic elements is considered; the experimental equipment to be used for this research is discussed. (M.L.S.)

32021 DIFFERENT ACTIVATION TECHNIQUES FOR THE STUDY OF EPITHERMAL SPECTRA, APPLIED TO HEAVY-WATER LATTICES OF VARYING FUEL-TO-MODERATOR RATIO. Sokolowski, Evelyn K. (Aktiebolaget Atomenergi, Studsvik, Sweden). J. Nucl. Energy, 21: 35-53(Jan. 1967).

Spectral indices at the cell boundary were studied as functions of lattice pitch in the reference core of the Swedish R–O reactor. Epithermal indices were determined by activation of ^{115}In, employing three different techniques: the two-foil, the Cd ratio, and the sandwich foil methods. The latter of these has the advantage of being independent of assumptions about foil cross sections of spectral functions, and it gives a spectrum index that lends itself readily to comparisons with theoretical multigroup calculations. Alternatively, the results can be expressed in terms of the Westcott parameters r and T_n when this is justified by the spectral conditions. The agreement among the three methods investigated is generally good. Good agreement is also found with multigroup collision probability calculations of different degrees of complexity. (auth)

32022 APPROACH TO THE SOLUTION OF CRITICALITY PROBLEMS IN HETEROGENEOUS MEDIA BY COUPLING THE TRANSPORT AND DIFFUSION THEORY. Chiovato, O. G.; Clerici, G. C. (ARS, Milan). J. Nucl. Energy, 21: 393-401(May 1967).

A new technique is described for the solution of criticality problems. Transport theory, in its integral form, is applied in the multiplying region, while diffusion theory is employed in the moderating region. The equations valid for a general geometry are obtained in two-group approximation. A numerical iterative scheme is developed for a multiplying reflected slab. The results obtained for a sample case are described. (auth)

32023 INVESTIGATION OF NEUTRON STREAMING USING THE PULSED NEUTRON SOURCE TECHNIQUE. Page, R. W. (Univ. of Southampton, Eng.). J. Nucl. Energy, 21: 403-15(May 1967).

The radial streaming of neutrons from H_2O moderated assemblies pierced by a uniform array of cylindrical voids is investigated by the pulsed neutron source technique. A method of synthesis is developed by which the fundamental mode in the spatial distribution of the thermal neutron flux within a moderator assembly may be readily extracted from experimental data. The decay constants determined by the synthesis method are used to derive the magnitude of the radial diffusion constant $D_r v$. The value of $D_r v$ agrees with that predicted by the theory of Leslie. (auth)

32024 NEW METHOD FOR THE EXACT MEASUREMENT OF THERMAL NEUTRON DISTRIBUTION IN AN ELEMENTARY CELL. Takac, S. M.; Krcevinac, S. B. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). J. Nucl. Energy, 21: 233-40(Mar. 1967).

Exact measurement of thermal neutron density distribution in an elementary cell necessitates a knowledge of the perturbations involved in the cell by the measuring device. A method was developed in which special emphasis is made to evaluate these perturbations by measuring the response from the perturbations introduced in the elementary cell. The unperturbed distribution was obtained by extrapolation to zero perturbation. The final distributions for different lattice pitches were compared with a THERMOS-type calculation, and very good agreement was reached. (auth)

32025 CALCULATION OF RATIOS IN CRITICAL SYSTEMS. Pomraning, G. C. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Nucl. Energy, 21: 285-91(Mar. 1967).

For the calculation of an arbitrary ratio of processes in a critical system a variational principle is presented which is a special case of a more general principle for eigenvalue problems. The principle requires a knowledge of only one adjoint function, and in this sense is more efficient than that of Lewins. (UK)

32026 BROOKHAVEN HIGH FLUX BEAM REACTOR: DESIGN AND USE. Kouts, Herbert J. Atoomenergie Haar Toepass., 9: 89-95(Apr. 1967).

A review of the design of the HFBR is given. Characteristics of the neutron flux in energy groups are presented; the thermal flux and its adjoint are discussed; proton recoil neutron flux from beam tubes is considered. The experimental facilities and their location with respect to the core are tabulated. A three-dimensional plot of power density relative to core average vs. (x,y) position in core is shown. A scale-down drawing of the crystal spectrometer is shown. (M.L.S.)

32027 NUCLEAR REACTOR. (to American Machine and Foundry Co.). British Patent 1,074,089. June 28, 1967. Priority date Sept. 25, 1963, United States.

A pulsing reactor is described which is capable of providing steady state radiation suitable for long time-period power operation and capable of pulse operation at high power levels for short time periods. UO_2 fuel elements are used. (J.R.D.)

32028 FAST FUEL TEST REACTOR. (to U. S. Atomic Energy Commission). British Patent 1,073,508. June 28, 1967. Priority date Mar. 9, 1965, United States.

A reactor which is useful for developing and testing fuel elements for fast reactors is described. The reactor is so designed that the core has a minimum of voids. (J.R.D.)

Reactor Components, Fuels and Accessories

Refer also to abstracts 30977, 30988, 30993, 31007, 31011, and 31080.

32029 (AECL-2695) URANIUM AND PLUTONIUM ISOTOPES IN NPD FUEL BUNDLE 1016. Griffiths, J.; Lounsbury, M.; Durham, R. W. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Mar. 1967. 29p. (CRRP-1246). Dep. CFSTI. CAN $1.00.

Fuel bundle 1016 was irradiated in the NPD reactor to ~1.5 n/kb. Chemical and mass spectrometric measurements have been made of Pu/U ratio, ^{235}U depletion and Pu isotopic composition. The computer codes LATREP, POOOF-BURN and CARIBOU have been used to predict the nuclide content, and the calculated results are compared with the experimental results. On the average, the agreement is better than ±3%. The effect of using POOOF-BURN in place of its predecessor SPOOOF in the NPD simulation procedure is estimated. (auth)

32030 (BNWL-419) THE ATR HIGH-TEMPERATURE HELIUM LOOP MODEL DESCRIPTION AND CAPABILITIES. Jackson, P. M.; Evans, R. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1967. Contract AT(45-1)-1830. 18p. Dep. CFSTI.

Construction features, current application, and potential future applications of a high temperature, high purity, He gas loop is described. The loop is an approximate one-tenth scale model of a high temperature materials-testing He gas loop under construction at the Advanced Test Reactor (ATR). The model loop is being used as a pilot operation for the ATR Gas Loop and as an out-of-reactor control in evaluation of specimen assemblies to be irradiated in the ATR Gas Loop. (auth)

32031 (BNWL-SA-1065-S) IRRADIATION OF IMPACTED, UO_2-PuO_2, PACKED-POWDER FUEL. Bailey, W. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 27, 1967. Contract AT(45-1)-1830. 5p. (CONF-670602-7). Dep. CFSTI.

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif.

Results of examination of irradiated pneumatically-impacted, 1.5 wt % PuO_2-UO_2, vibrationally-compacted, Zircaloy-clad fuel rods are reported. Examination of three fuel rods (148 cm long) with burnups to 9220 MWd/tonne and 30 capsules (8 to 10 cm long) with burnups to 18,300 MWd/tonne showed no fuel-Zircaloy interaction. Analytical data on burnups and isotopic concentrations in 25 specimens indicate good agreement with predicted values derived from flux-monitoring wire burnup and computer isotopic data. (P.G.C.)

32032 (IFA-FR-50) COLLISION PROBABILITIES IN NUCLEAR REACTOR THEORY. Bibliography. Rosescu, Teodor (Academia R. P. R., Bucharest, Institutul de Fizica Atomica). 1966. 15p. Dep.

The bibliography contains 109 references on collision probabilities in nuclear reactor theory. Availability listings are given. (J.C.W.)

32033 (IFA-FR-56) S_n (CARLSON) APPROXIMATION IN NEUTRON TRANSPORT THEORY. [Bibliography]. Rosescu, Teodor (Academia R. P. R., Bucharest. Institutul de Fizica Atomica). 1966. 17p. Dep.

The bibliography contains 100 references on S_n (Carlson) approximation in neutron transport theory. Availability listings are included. (J.C.W.)

32034 (RISO-M-546) NON-MAGNETIC METAL CRACK DETECTOR. Diamond, J. M. (Danish Atomic Energy Commission, Risoe, Research Establishment). Apr. 1967. 13p. (R-7-67). Dep.

An eddy-current instrument is described for measuring the depth of cracks in nonmagnetic metal walls. Depths from a fraction of a millimeter to 10 mm are readily observed, but the instrument does not always distinguish vertical from inclined cracks. (auth)

32035 (RT/FI(67)-8) BURNY: UN PROGRAMMA DI BURN-UP A DUE DIMENSIONI. (BURNY: A Two Dimensional Burn-Up Code). Buffoni, G.; Lopez, S.; Maganzani, I. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1967. 22p. (In Italian). Dep.

BURNY is a two dimensional (XY or RZ) burn-up code utilizing the code EQUIPOISE for two group power distribution calculation. The input-output procedure and the flow diagram are given. (auth)

32036 (TID-3584(Rev.1)) NUCLEAR ENERGY FOR WATER DESALTING. A Bibliography. Kuhns, Helen F. (Oak Ridge National Lab., Tenn.); Raleigh, Henry D.; Steele, Myrna L. (comps.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). May 1967. 40p. Dep. CFSTI.

References to 215 publications on the use of nuclear energy in the production of potable water from saline or brackish waters are included in the bibliography. The uses of nuclear reactors, radioisotopic heat sources, and nuclear explosives are covered in relation to the various possible desalination methods available. Author and report number-availability indexes are included. (auth)

32037 (ORNL-tr-1678) FRENCH REGULATIONS CONCERNING PRESTRESSED CONCRETE REACTOR PRESSURE VESSELS. Translated by Gregory L. Boisvert (Oak Ridge National Lab., Tenn.), from a French report. 34p. Dep. CFSTI. JCL $3.60 fs, $1.22 mf.

Regulations concerning metal-armored prestressed concrete reactor structures containing pressurized fluids are presented. Construction and preparation, materials, design, structure tests, monitoring and safety devices, and operational use are considered. (M.C.G.)

32038 MEASUREMENT OF THE TEMPERATURE COEFFICIENT OF THE EFFECTIVE RESONANCE INTEGRAL FOR URANIUM CARBIDE. Tassan, S.; Haemers, L.; Boeuf, A. (EURATOM-CCR, Ispra, Italy). Energ. Nucl. (Milan), 14: 289-94(May 1967).

The temperature coefficient of the effective resonance integral of a UC rod, 13 mm dia, was measured at 20 to 820°C, using an activation technique. The resonance integral has been expressed as a linear function of $\sqrt{T}$, yielding the Doppler coefficient $\beta = (0.69 \pm 0.03) \cdot 10^{-2}/°K^{\frac{1}{2}}$, in agreement with the results of theoretical calculations as well as of previous measurements of β carried out for U and UO_2. (auth)

32039 CALCULATION OF FISSION-PRODUCT GAS PRESSURES IN OPERATING UO_2 FUEL ELEMENTS. Notley, M. J. F. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Appl., 3: 334-42(June 1967).

A method has been evolved for the calculation of the fission-product gas pressure inside operating UO_2 fuel elements. The calculations are based on a model in which the hot center of the UO_2 pellet is assumed to flow plastically under stress, and the outer annulus is cracked. The calculated pressures are shown to be in reasonable agreement with experimental measurements of the gas pressure inside fuel elements. (auth)

32040 CRUSH STRENGTH APPARATUS WITH A PHOTOCELL DETECTION UNIT. Amos, W. R.; Burgess, E. T.; Mershad, E. A. (Mound Lab., Miamisburg, Ohio). Rev. Sci. Instrum., 38: 910-12(July 1967).

An apparatus utilizing a photocell detection system was designed and built to measure the force required to crush a spherical particle 0.05 to 0.5 mm in dia. The force applied to the particle causes a variation in light area on two matched photocells. The signal from the unbalance in the photocells is recorded without amplification on a millivolt recorder as the particle is crushed. Standardization is accomplished by placing known weights on the apparatus and measuring the displacement on a recorder. The apparatus can be used to measure crush strengths from 0.080 to 2500 g. (auth)

32041 AN IN-PILE LOOP FACILITY FOR IRRADIATION OF MATERIALS AT TEMPERATURES UP TO 400°C. Fischer, E.; Hattenbach, K.; Melkonian, G. A. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Kerntechnik, 9: 189-94(May 1967). (In German).

To investigate the radiation effect on materials, an in-pile loop facility has been constructed at the Geesthacht research reactor in which the temperature of the irradiated samples can be maintained by means of cooling with an organic liquid. Irradiation of non-fissile material seems to be practicable with a low-temperature difference in the irradiation volume at 180 to 400°C. If higher temperature differences are admitted the irradiation of fuel-element samples is possible for total nuclear powers up to 40 kW. (auth)

32042 NUCLEAR FUEL ELEMENTS. (to Atomic Energy of Canada Ltd.). British Patent 1,073,858. June 28, 1967. Priority date Aug. 28, 1964, Canada.

The design of fuel elements having several layers to provide resistance to swelling is described. The inner core contains U surrounded by U alloy. An outer sheath of corrosion-resistant Zr alloy is provided. (J.R.D.)

32043 IMPROVEMENTS IN OR RELATING TO NUCLEAR POWER PLANT. (to Babcock and Wilcox Ltd.). British Patent 1,073,055. June 21, 1967. Priority date Mar. 25, 1964, Germany.

A nuclear vapor generating plant having a spherical pressure vessel radially symmetrical about a vertical axis is designed. The pressure vessel accommodates all the reactor core components. (J.C.W.)

32044 AUTOMATIC COUPLING AND DECOUPLING DEVICE. Riemenschneider, Helmut (to European Atomic Energy Community (EURATOM)). British Patent 1,073,061. June 21, 1967. Priority date Mar. 9, 1964, Germany.

The design of an automatic couple between two reactor fuel elements which are movable in relation to one another is given. (J.C.W.)

32045 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Sinclair, William Norman (to United Kingdom Atomic Energy Authority). British Patent 1,073,296. June 21, 1967. Filed Apr. 30, 1964.

A combination of a fuel handling machine, a condenser, and a water cooler outside the reactor shielding constitute the design for reactor servicing. (J.C.W.)

32046 END SYSTEM FOR FUEL ELEMENTS FOR NUCLEAR REACTORS. Bourdinaud, Pierre; Lestiboudois, Guy; Rouge, Pierre (to Commissariat a l'Energie Atomique). British Patent 1,072,326. June 14, 1967. Priority date Sept. 27, 1963, France.

An end arrangement for the fuel elements of nuclear reactors in which the fuel elements are stacked vertically upon one another in graphite channels is described. (J.C.W.)

32047 IMPROVEMENTS RELATING TO ROTARY WINDING MEANS FOR A CABLE OR HOSE. Holladay, John Alexander (to Fairey Engineering Ltd.). British Patent 1,071,784. June 14, 1967. Filed Sept. 5, 1962.

A winding apparatus for an elongated flexible cable on a rotary winding drum is described. The device is employed in connection with an electrically driven fuel element hoist in a nuclear power station where the operating conditions prevent the use of slip-rings. (J.C.W.)

32048 ELECTRONIC PARAMAGNETIC RESONANCE SPECTROMETER FOR A NUCLEAR REACTOR. Santier, Daniel Galland Christian; Servoz-Gavin, Pierre; Soutif, Michel (to Commissariat a l'Energie Atomique). British Patent 1,072,667. June 21, 1967. Priority date May 7, 1965, France.

An electronic paramagnetic resonance spectrometer is described. It is used for detection of the defects produced in solid specimens irradiated by a submerged source. (J.C.W.)

GENERAL

32049 (BNWL–392) ANALOG TECHNIQUE FOR OPTIMIZING DYNAMIC SYSTEMS. Harvey, R. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1967. Contract AT(45-1)-1830. 15p. Dep. CFSTI.

An iterative analog program has been developed for optimizing a sampled quadratic-like function of an independent parameter. A minimum-seeking sampled dynamic system is discussed with results that show the effects of changing the control loop gain. The program and results for a digital computer implementation using the MIMIC program are presented also. (auth)

32050 (COO–614-52) ICR QUARTERLY REPORT NUMBER 12. Yngve, Victor H. (Chicago Univ., Ill. Inst. for Computer Research). Feb. 1, 1967. Contract AT(11-1)-614. 121p. Dep. CFSTI.

The discussion includes Maniac III engineering activity, the Man-Machine Project, file-handling, input-output, and monitoring procedures for use with the SNOBEL language, an approach to formal semantics, an experimental method for testing numerical stability in initial value problems, and a class of simple combinatoric patterns of automorphisms equivalent to Veblen–Wedderburn planes, and a lower bound for the number of independent complete sets of mutually orthogonal Latin squares. Also force correlations in finite gravitational systems, approximation-solvability of nonlinear equations, and a mode of computer-aided instruction are covered. (J.F.P.)

32051 (IS–1589) STUDY OF THE ENERGY LEVELS OF ERBIUM ETHYLSULPHATE CRYSTALS. Eckroth, Charles Angelo; Spedding, F. H. (Ames Lab., Iowa). Feb. 1966. Contract W-7405-eng-82. 129p. Dep. CFSTI.

The low temperature absorption spectrum of erbium ethylsulphate hydrated crystals is extended into the infrared and ultraviolet regions to 4366 cm^{-1}. The Zeeman splittings are given for 17 Kramers' pairs of levels not previously reported, and the zero field energies are given for 24 new pairs of levels. Included in these numbers are superimposed levels not previously known to be such. The $^2P_{\frac{1}{2}}$ multiplet was found in the near ultraviolet and other ultraviolet multiplets were identified to confirm and extend previous assignments. Data are presented which show the effect on the energy levels of using crystals diluted with yttrium ethylsulphate. The anisotropic Zeeman splitting when the magnetic field is perpendicular to the crystal C-axis is also shown. Group theoretical arguments are used to study the energy levels and selection rules for a magnetic field perpendicular to the C-axis, by assuming the ligand field symmetry is approximately D_{3h}. The 364×364 secular determinant can be factored into two parts in this case by using a suitable set of basis functions. The selection rules for low, moderate and high magnetic fields perpendicular to the C-axis are developed. The 60° periodicity in the Zeeman polarization patterns of some lines during rotation of the crystal about the C-axis follows directly from the transformation properties of the basis functions which factor the secular equation. (auth)

32052 (IS-T–143) ELLIPTIC INTEGRALS OF THE THIRD KIND. Zill, Dennis Gene (Ames Lab., Iowa). May 1967. Contract W-7405-eng-82. 102p. Dep. CFSTI.

Thesis.

Two functions $R_J(x,y,z,\rho)$ and $R_H(x,y,z,\rho)$, which are partially symmetric homogeneous hypergeometric functions, are considered. Either one of these functions can serve as a replacement for Legendre's normal elliptic integral of the third kind. The complete symmetry of $R_{J,H}(x,y,z,\rho)$ in x,y,z is shown to obviate the linear transformations, in Legendre's notation, on the amplitude φ and modulus k. Also, the linear transformations involving the parameter α^2, the so-called change-of-parameter relations, are derived. An additional and apparently new transformation is obtained. The interchange theorem as well as the theorem on addition of amplitudes is rephrased in the new notation. The addition theorem yields a duplication formula which is useful in numerical evaluation of R_J and R_H. Since symmetry in three arguments supersedes a set of linear transformations, it was not unexpected that in this new formulation the quadratic Landen and Gauss transformations assume a unified form. Iterative use of these transformations provides a method for numerical evaluation of the functions. Two surprisingly elegant computational algorithms for R_J, based on the descending Gauss and ascending Landen transformations, are derived. Another procedure for calculating R_J, based on an infinite series, is also considered. Some inequalities for R_J are examined which are illustrated by several numerical examples. Three appendices contain a table of reduction formulas, numerical tables of R_J and R_H, and two Fortran programs. (auth)

32053 (IS-T–167) PRECISE EIGENVECTOR BASIS FOR A SYMMETRIC MATRIX. Sincovec, Richard Frank (Ames Lab., Iowa). May 1967. Contract W-7405-eng-82. 53p. Dep. CFSTI.

Thesis.

A new theorem is proved to the effect that if a rank-one matrix of the form $\bar{x}\,\bar{x}'$, where $\bar{x}$ is a column vector and $\bar{x}'$ is its transpose, commutes with a symmetric matrix A, then $\bar{x}$ is an eigenvector of A. This fact enables one to compute an eigenvector with nearly the precision of the computer by the following algorithm: Define $R_0 = A\,\bar{x}_0\bar{x}_0' - \bar{x}_0\bar{x}_0'A$ where $\bar{x}_0$ is an arbitrary non-zero vector. Define $\bar{x}_1 = \bar{x}_0 + t_0\bar{g}_0$ where $\bar{g}_0$ is an appropriately chosen change vector and t_0 is an optimum parameter so that the matrix $R_1 = A\bar{x}_1\bar{x}_1' - \bar{x}_1\bar{x}_1'A$ has a smaller norm than R_0. This procedure is continued iteratively until a residual matrix R_m is found with norm sufficiently close to zero. Then the corresponding vector $\bar{x}_m$ is taken as the eigenvector. A systematic procedure for choosing the change vectors $\bar{g}_m$ is devised and a procedure for finding all the eigenvectors is developed. An analysis is made which gives the necessary and sufficient conditions that an eigenvector of the given matrix must satisfy with respect to the iterative procedures. Also it is proved that the iterative procedure is convergent and that the sequence of eigenvector approximations does not converge to the zero vector. An example is given to illustrate the proposed method. (auth)

32054 (K–1696) MULTIBULB VISCOMETER. Kermicle, H. A. (Oak Ridge National Lab., Tenn.). June 13, 1967. Contract W-7405-eng-26. 16p. Dep. CFSTI.

A three-bulb glass viscometer for semiautomatically determining the efflux times of a liquid at three different consecutive shear rates is described. Data are obtained by measuring the time required for the sample level to fall between a pair of meniscus detectors located above and below each bulb along a vertical tube. The meniscus detector assemblies utilize a common exciter lamp, flexible fiber-optics light pipes to transmit the optical signals, and photoconductive cell bridges. Solid state amplifiers are employed to actuate precision timers which store the efflux time data until reset. The timer storage capacity is 1000 seconds in 0.1 second increments, and a readout resolution of ±0.02 seconds can be attained by interpolation. A maximum overall error (95% C.I.) of 0.14 second was obtained using a distilled water sample in a stirred but not temperature-controlled water bath. The sample requirement for the instrument is 4.5 to 5.5 ml. (auth)

32055 (K-DP–2413) SAMPLING MOMENTS OF MOMENT AND MAXIMUM LIKELIHOOD ESTIMATORS FOR DISCRETE DISTRIBUTIONS. Shenton, L. R.; Bowman, K. O. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center); Reinfelds, Juris (Georgia Univ., Athens. Computer Center). [1967]. Contract W-7405-eng-26. 43p. Dep. CFSTI.

A generalized recursive formula is given for the expectation of a certain product of powers of orthogonal statistics. This includes a recursive scheme, suitable for a digital machine, for the expectation of products of powers of crude sample moments. The result is useful in studying the distributional properties of moment estimators and generalized moment estimators. (B.G.D.)

32056 (MATT–540) TWO-DIMENSIONAL MEASURE PRESERVING MAPPINGS. Greene, John M. (Princeton Univ., N. J. Plasma Physics Lab.). June 1967. Contract AT(30-1)-1238. 34p. Dep. CFSTI.

A particular area-preserving mapping of a plane onto itself was studied in detail with the aid of a digital computer. A large number of fixed points, finite sets of points that transform into each other, were located and classified as elliptic or hyperbolic depending on the nature of the linearized mapping in the neighborhood. A quantity called the residue was calculated for each fixed point. This quantity can be used to predict whether other nearby fixed points are elliptic or hyperbolic. The results showed that there are considerable regions in which almost all the fixed points are hyperbolic. Further calculations were made to estimate the area enclosed by the invariant curves whose existence has been established by Moser. The boundary of this region appeared to coincide with the boundary of the region in which almost all the fixed points are hyperbolic. (auth)

32057 (NVO–266-1) WATER SURFACE WAVE MEASUREMENT EXPERIMENT: MONO LAKE. Final Report. (Oceanographic Services, Inc., Santa Barbara, Calif.). Jan. 1967. Contract AT(26-1)-266. 61p. Dep. CFSTI.

During July, August, and September, 1966, field operations were conducted by the U. S. Army Waterways Experiment Station at Mono Lake, California. A portion of these operations included the

detonation of spherical cast TNT charges weighing approximately 9,200 pounds. Oceanographic Services, Inc., under contract to the U. S. Atomic Energy Commission, monitored the explosion-generated water waves to include the subsequent shoaling and runup of these waves. The data so obtained are to be utilized in predicting wave effects along other irregular shorelines. The field operation, data reduction, and preliminary data analysis portions of the program are presented. (auth)

32058 (ORO-2430-37) A COMPUTER SOLUTION FOR THREE-DIMENSIONAL TIME-INVARIANT, CONSERVATIVE FIELDS. Metz, Walter C. Jr. (Duke Univ., Durham, N. C. Dept. of Electrical Engineering). June 1967. Contract AT(40-1)-2430. 211p. Dep. CFSTI.

Thesis.

A method of obtaining computer solutions to three-dimensional boundary-value problems involving time-invariant conservative fields is described. A further restriction that these fields exist in an isotropic linear and piecewise-homogeneous medium was imposed although this limitation is not inherent in the basic formulation. The technique is applicable to the Dirichlet, Neumann, and mixed boundary types. The method is based on a surface integral form of Poisson's equation which gives explicitly the potential function at any point in the field. In a given problem, the equation is written for the potential at points on specific surfaces in the field. The resulting set of integral equations is then approximated by a set of linear algebraic equations, the variables being unknowns at points on the surfaces. The simultaneous equations are solved by a digital computer and the solutions substituted in the integral equation to give the potential anywhere in the field. Numerical approximation of a two-dimensional integral equation thus effectively reduces the three-dimensional problem to a two-dimensional problem. The alternate approach of solving difference equations which approximate the differential form of Poisson's equation is impractical for even the most powerful computers. (B.G.D.)

32059 (ORO-2572-13) ENGLISH SPOKEN DIGIT DATA SAMPLER. Resnikoff, H. L.; Sitton, G. A. (Rice Univ., Houston, Tex. Dept. of Electrical Engineering). June 1967. Contract AT(40-1)-2572. 160p. Dep. CFSTI.

An English spoken digit sampler which is a primary data reference volume designed to illustrate the physical and linguistic properties of the English spoken digits 0(/0/), 1, 2, 3, 4, 5, 6, 7, 8, and 9 is described. The data is exhibited in a form that allows both visual inspection and quantitative analysis, with emphasis on the latter aspect. (B.G.D.)

32060 (ORO-3108-28) DETERMINATION OF THE SURFACE STRESS OF GOLD. Mays, Claude Wayne (Virginia Univ., Charlottesville). June 10, 1967. Contract AT(40-1)-3108. 54p. Dep. CFSTI.

Thesis.

The relationship between surface tension and surface stress is discussed. Equations relating these properties are derived. The surface stress of gold is determined by comparing values obtained for the lattice constants of different sized gold nuclei with those obtained for a continuous film of the same material. (J.C.W.)

32061 (SC-DC-67-1773) CASE HISTORY: REAL-TIME PROCESS. Montoya, E. K. (Sandia Corp., Albuquerque, N. Mex.). May 1967. Contract AT(29-1)-789. 15p. (CONF-670531-1). DTIE.

From American Management Association Orientation Seminar, New York.

The testing procedure involving an on-line computer operating in the real-time mode used to check out a series of detection satellites is described. A description of the system, as well as some of the problems encountered, are discussed. Particular emphasis is placed on the software which was designed to allow for engineering design changes of the hardware, with a minimum of program rewriting. A summary of the results obtained is also presented. (auth)

32062 (SC-DC-67-1782) RESPONSE OF A TERMINATED TWO-WIRE LINE BURIED IN THE EARTH AND EXCITED BY A PLANE-WAVE RF FIELD GENERATED IN FREE SPACE. Harrison, Charles W. Jr.; Houston, Margaret L. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1966. Contract AT(29-1)-789. 42p. Dep. CFSTI.

A terminated two-wire transmission line was buried at constant depth near the earth-air interface with one conductor directly below the other. A plane-wave electromagnetic field, generated in free space, impinges upon the boundary where it undergoes partial reflection and transmission. The field transmitted into the earth excites the transmission line. The polarization of the electric field is chosen such that the field is directed parallel to the line conductors. The interaction of the line with the dispersive medium and the line losses are considered. The objective of the study is to determine the current in specified load impedances in terms of the amplitude of the incident electric field evaluated at the surface of the earth. (auth)

32063 (SC-DC-67-1821) APPROXIMATION OF EIGENVALUES AND EIGENFUNCTIONS OF CONVOLUTION KERNELS. Roark, Adelbert Lee (New Mexico Univ., Albuquerque. Dept. of Mathematics). May 1967. Contract AT(29-1)-789. 76p. Dep. CFSTI.

The problem of approximating the eigenvalues and eigenfunctions of certain displacement integral equations, that is, equations of the form $\lambda\varphi(x) = \int_{-a}^{a}\varphi(y)K(s|x-y|)dy$ (1) where K(z) is a continuous real-valued function for $0 \leq |z| \leq 2as$ and s is a positive parameter. Particular interest is directed to kernels which become highly oscillatory as s becomes large since conventional numerical methods are not satisfactory. By considering kernels which are expressible as various transforms of integrable functions, the set of eigenvalues of (1) are shown to be the same as the combined set of eigenvalues of two infinite matrices. It is then shown that the eigenvalues and eigenvectors of the corresponding truncated matrices converge to those of the corresponding infinite matrix. The eigenfunctions are then given as a uniformly convergent series in terms of the eigenvectors of the matrices. Three advantages of the method developed are: that no explicit knowledge of the transform is needed, since only the form of the kernel is used; secondly, that the truncated problems are readily solved numerically; and finally, that the computational difficulties are relatively independent of the size of the parameter s. Next, we consider $\lambda\varphi(x) = \int_{-a}^{a}\varphi(y)K[s(x-y)]dy$ where K(z) is a continuous, not necessarily real-valued function for $-2as \leq z \leq 2as$ and s is a positive parameter. (Equation (2) is considered since if K(z) is real-valued and even, equation (2) reduces to (1).) Using techniques similar to those used in (1) a similar method is obtained for equation (2) when K(z) is given as a Fourier transform. Finally, specific numerical examples of (1) which have been considered in the literature are examined. They illustrate the usefulness and accuracy which can be achieved by the use of this method. (auth)

32064 (SC-DR-67-60) DEVELOPMENT OF EMPIRICAL EQUATIONS FOR PREDICTING DEPTH OF AN EARTH-PENETRATING PROJECTILE. Young, C. W. (Sandia Corp., Albuquerque, N. Mex.). May 1967. Contract AT(29-1)-789. 40p. Dep. CFSTI.

An empirical equation is presented which allows a reasonably accurate prediction of the depth to which a projectile will penetrate the earth. Tables of soil constants and nose-performance coefficients are given for use in the equation. (auth)

32065 (SC-DR-67-494) THE THUMPATRON: AN INSTRUMENT FOR DETERMINING THE DIRECTION OF POLARIZATION OF FRAGILE PIEZOELECTRIC SAMPLES. Ingram, G. E. (Sandia Corp., Albuquerque, N. Mex.). June 1967. Contract AT-(29-1)-789. 10p. Dep. CFSTI.

An instrument which has been used for a number of years in nondestructive testing of many types of piezoelectric and ferroelectric materials is described. The instrument detects the initial polarity of the rapidly fluctuating electric fields generated by these materials when they are subjected to a low amplitude plane-compressive strain pulse. The strain pulse is created by a gentle mechanical thump propagating as a plane wave into the specimen from an adjacent solid electrode. This dynamic force application technique has eliminated the sample breakage problem which was prevalent during conventional static testing. Shear forces, common in static testing, are eliminated, thus reducing the polarity uncertainty problem. (auth)

32066 (SC-M-67-4) ENVIRONMENTAL FACILITY CALIBRATION PROCEDURES. Bauer, E. M. (Sandia Corp., Albuquerque, N. Mex.). May 1967. Contract AT(29-1)-789. 47p. Dep. CFSTI.

Supersedes SC-M-64-61.

Procedures covering instrumentation, equipment, and methods presently in use at Sandia Corporation for calibrating environmental test facilities are set forth. General guidance is intended in order to help promote uniformity of test results. (auth)

32067 (SC-RR-66-658) A LARGE DEFLECTION STRAIN RATE-VELOCITY RELATION FOR A GENERAL SHELL UNDER THE KIRCHHOFF ASSUMPTION. Krieg, Raymond D.; Key, Samuel (Sandia Corp., Albuquerque, N. Mex.). June 1967. Contract AT(29-1)-789. 21p. Dep. CFSTI.

An expression for the strain rate in a shell is derived using the concepts of tensor calculus. The Kirchhoff assumptions are imposed but large deflections are allowed. The Lagrangian strain rate tensor is chosen as the pertinent parameter. A physical interpretation of the result is given. The solution is particularized

for a shell which has no variation of geometry in one of the principal directions. (auth)

32068 (SC-RR-67-176) STABILITY AND AXIAL FORCE TESTS OF THE STANDARD HYPERVELOCITY BALLISTIC MODELS HB-1 AND HB-2 AT MACH NUMBERS OF 5.3, 7.5, AND 11.4. Millard, William A. (Sandia Corp., Albuquerque, N. Mex.). May 1967. Contract AT(29-1)-789. 31p. Dep. CFSTI.

The Supersonic Tunnel Association standard hypervelocity ballistic correlation Models HB-1 and HB-2 were tested in the Sandia Laboratory 18-Inch Hypersonic Wind Tunnel to determine the static stability and axial force coefficients at M = 5.3, 7.5, and 11.4. These results are compared with force data obtained for similar models in the AEDC wind tunnels. The comparisons indicated only relatively minor discrepancies between the data from the two facilities. (auth)

32069 (SC-RR-67-251) ANALYSIS OF PRESSURE MEASUREMENTS TAKEN AT ALTITUDES BETWEEN 30 AND 90 KM BY CONE-CYLINDER PITOT-STATIC PROBES. Rigali, D. J.; Touryan, K. J. (Sandia Corp., Albuquerque, N. Mex.). June 1967. Contract AT(29-1)-789. 37p. Dep. CFSTI.

Data from four Nike-Apache sounding rocket flights of cone-cylinder pressures probes are analyzed. The carrier rockets and the instrumentation are discussed in detail. Special emphasis is placed on error analyses, and the results are compared with two sets of data from falling sphere tests. Future plans are reviewed. (auth)

32070 (SC-TM-67-290) TRACK SWITCH/MINUS TWO RELAY BOX. Farrelly, Stephen (Sandia Corp., Albuquerque, N. Mex.). May 1967. Contract AT(29-1)-789. 9p. Dep. CFSTI.

A track switch/minus two relay box is described which is part of a system to actuate cameras covering the Area III sled tracks. The box combines a 110V ac switch closure side and a 28V dc switch closure and circuit break side. (auth)

32071 (SCL-CR-67-179) DOCUMENTATION OF A CONVERSION OF GECENT III FOR USE WITH CDCAPT3. Knauff, W. J.; Quock, H. (California Univ., Livermore. Lawrence Radiation Lab. Sandia Corp., Livermore, Calif.). June 1967. Contracts AT(29-1)-789; 18-4354. 59p. Dep. CFSTI.

A documentation of computer program statement changes necessary to operate GENCENT III on a CDC 3600 or CDC 3800 as a postprocessor to CDCAPT3 is presented. (auth)

32072 (TID-23783) STRESS SOLUTION FOR AN INFINITE PLATE UNDER EQUAL BI-AXIAL STRESS CONTAINING TWO CIRCULAR HOLES OF UNEQUAL RADII. Report No. 113. Salerno, V. L. (Applied Technology Associates, Inc., Ramsey, N. J.). Mar. 1967. Contract W-7405-eng-26; Subcontract No. 2752. 50p. Dep. CFSTI.

A method of successive approximations, utilizing analytic stress functions of the complex variable z, in the manner of the Schwartz Alternating Method was used to obtain the solution of the stress distribution around two circular holes of unequal radii in an equal bi-axial stress field of an infinite plate. The stress functions up to a third approximation are obtained for the problem and several numerical examples are given which denote the accuracy and degree of convergence of the process. It is believed that this basic solution for two holes may be used to obtain solutions to more complicated hole patterns. (auth)

32073 (TID-23857) ASSOCIATED COLLEGES OF CHICAGO AREA LECTURES ON POINT SYMMETRY. McMillan, Juan A. (Argonne National Lab., Ill.); McMillan, Clara A. (Saint Procopius Coll., Lisle, Ill.). June 1967. Contract W-31-109-eng-38. 77p. Dep. CFSTI.

The theory of symmetry is discussed under the following headings: the group of symmetry operations, multiplication table, subgroups and descending symmetry, class of symmetry operations and similarity transformation, the symmetry matrix, point symmetry operations, the character of the symmetry matrix, representation of groups, basis for a representation, complex characters, and Mulliken symbols. Applications of symmetry to the molecular point groups, the crystallographic groups, the O_h group and its subgroups, the D_{6h} group and its subgroups, directed valence in hydridization of orbitals, and crystal-field splitting of electronic levels are considered. (M.C.G.)

32074 (UCRL-50252) THERMALLY GENERATED STRESS WAVES IN A DISPERSIVE ELASTIC ROD. Percival, C. Mark (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 28, 1967. Contract W-7405-eng-48. 102p. Dep. CFSTI. Thesis.

The propagation of thermally generated stress waves in a dispersive elastic rod is investigated both experimentally and analytically. In the experimental investigation, the end of a circular colored glass rod is heated very rapidly by the deposition of luminous energy from a Q-switched ruby laser. The light from the laser is directed parallel to the axis of the rod and deposited on the polished end of the rod. The absorptivity of the glass for light emitted by the laser is such that the depth of penetration is of the same order as the radius of the rod. The length of the energy pulse from the laser is 20 nsec (i.e., 20×10^{-9} sec). This results in heating at such a rate that it can be considered as instantaneous when compared to the mechanical response of the material used. The resulting stress wave is measured using a thin quartz crystal in a Hopkinson pressure-bar arrangement. Dispersion precludes the use of the simple wave equation, so Love's modified wave equation is used to describe the motion. The thermoelastic problem is reduced to a homogeneous partial differential equation with appropriate initial and boundary conditions, which is solved by the separation of variables technique. The experimental results are in good agreement with the theory. The amplitude of the stress waves was found to be directly proportional to the total energy deposited. The very short stress pulses generated by Q-switched laser deposition on the end of the thin rod gave rise to the higher modes of longitudinal wave propagation. The existence of wave propagation in a thin rod at near dilatational velocities was experimentally confirmed. It is concluded that the experimental techniques developed can be used to model stress wave generation due to electromagnetic energy depositions, and they also provide an efficient means for generating the higher modes of longitudinal wave propagation in thin rods. (auth)

32075 (UCRL-50255) DEFINITION OF THE LIVERMORE LISP LANGUAGE. Anderson, Gary (California Univ., Livermore. Lawrence Radiation Lab.). May 15, 1967. Contract W-7405-eng-48. 17p. Dep. CFSTI.

The syntax and semantics of the Livermore LISP language (LLISP) for the CDC 6600 Octopus system are described. (B.G.D.)

32076 (UCRL-50263) POWERED AIR-PURIFYING RESPIRATOR. Burgess, William A.; Nettleton, William (California Univ., Livermore. Lawrence Radiation Lab.). May 23, 1967. Contract W-7405-eng-48. 13p. Dep. CFSTI.

The advantages of a personal powered air-purification respirator were previously described. The device considered satisfies the design aim to provide a unit with a protection factor of 1000 against particulates when used with half-masks, full-face masks, rigid helmets, and hoods. The size, shape, and weight of the device are consistent with normal restraints of emergency and routine use. The design reflects the need for an inexpensive, all-purpose device for wide industrial application. Although the initial application of this device was with ultrahigh efficiency filters, its performance was also evaluated with medium-efficiency felt filters, activated charcoal canisters, and combination canisters. The design of the unit permits operation with a variety of battery packs. The standard pack is a rechargeable battery system that provides a life of approximately 3 hr with a nominal delivery of 5 cfm. Alkaline batteries provide an economical "one-shot" power supply with a battery life of approximately 14 hr with reduced delivery. (auth)

32077 (UCSD-34P-108-55(Pt.1)) RESEARCH ON THE MARINE FOOD CHAIN. PART I. INTRODUCTION AND ACCOUNT OF WORK IN PROGRESS. Period Covered: January 1966–December 1966. Strickland, J. D. H. (California Univ., La Jolla. Inst. of Marine Resources). Contract AT(11-1)-34. 70p. (IMR-67-9(Pt.1)). Dep. CFSTI.

PLANKTON—ingestion by grazing animals, factors affecting
PHOSPHORUS—analysis in sea water, device for automatic
NITROGEN—analysis in sea water, device for automatic
ULTRAVIOLET RADIATION—use for oxidation of organic phosphorus and nitrogen
ALGAE—growth of Coccolithus huxleyi and Ditylum brightwellii
CRUSTACEANS—sampling off California coast
CARBON—determination in bacteria and phytoplankton
NITROGEN—determination in bacteria and phytoplankton
ADENOSINE-5′-TRIPHOSPHATE—use in estimating heterotropic biomass off coast of Peru
ALGAE—growth rates of, determination of, from light absorption by cell chlorophyll
SEA WATER—isolation of dissolved organic matter from
PLANKTON—chemical composition of nitrogen- and phosphorus-deficient phyto-
CARBON-14—use in age estimation of dissolved organic matter in sea water
THIAMINE—determination in sea water
BIOTINS—determination in sea water
VITAMIN B_{12}—determination in sea water
BACTERIA—isolation of nitrifying, from sea water
BACTERIA—growth of nitrifying, in various oxygen tensions

ACETIC ACID—(ETHYLENEDINITRILO)TETRA-, iron complexes with, determination of, in sea water
HYDROXYLAMINE—determination in secondary nitrite layer off coast of Peru (H.G.D.)

32078 (AWRE-Trans-53) OVERLAP PROBABILITY OF FLAWS IN A LAMINATED DIELECTRIC. Held, W.; Klahn, R. J. Translated by F. E. Wallwork (Atomic Weapons Research Establishment, Aldermaston, Eng.), from Elektrotech. Z., 87A: 121-6(1966). 18p. Dep. CFSTI. UK 3s. 0d.

The individual layers of the insulation of capacitors, cables, transformers, etc., inevitably contain flaws, such as conducting inclusions and pinholes. Calculation is made of the probability of two, three or more flaws overlapping. It is found that in the dielectric of capacitors, for instance, overlaps of two flaws occur with a probability of 10^{-5} to $10^{-3}/m^2$, whereas overlaps of three or more are highly unlikely. Results from tests on power capacitors are compared with the calculated overlap probability of conducting inclusions in the paper. The technique employed enables an estimate to be made of the test failures in capacitors with three layers of insulating material, provided the number of flaws in the paper is known. (tr-auth)

32079 (LA-tr-66-79) A STUDY OF A SINGULARITY OF THERMODYNAMIC QUANTITIES AT THE LIQUID-VAPOR CRITICAL POINT OF A PURE SUBSTANCE. Voronel', A. V. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut Nizkikh Temperature). Translated by A. D. Cernicek (Los Alamos Scientific Lab., N. Mex.), from a Thesis. 19p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Measurements of the heat capacity as a function of temperature and density were made in the vicinity of critical points of argon, nitrogen, and oxygen in the region of homogeneous and two-phase states. Measurement data of more than 1000 points for these substances and several mixtures are presented. The measurement data are indicative of the presence in the critical point of all pure substances of the characteristic of the heat capacity as to T and V being contrary to the existing theory of critical phenomena. (M.O.W.)